PREFACE

HYDROGEN ENERGY is a continuing bibliographic summary with abstracts of research and projections on the subject of hydrogen as a secondary fuel and as an energy carrier. The first volume was published in January, 1974 and is cumulative through December of 1973. Additional copies are available from the Technology Application Center, as are the quarterly update series for 1974, 1975, 1976, 1977, and the first two quarters of 1978.

This update to HYDROGEN ENERGY cites additional references identified during the third quarter of 1978. It is the third in a 1978 quarterly series intended to provide "current awareness" to those interested in hydrogen energy.

For the reader's convenience, a series of cross indexes are included which track directly with those of the cumulative volume. See "Guide to Use of the Publication."

A library containing some of the articles and publications referenced in this update and the cumulative volume has been established and the Center will, on a cost-recovery basis, aid readers to obtain copies of any cited material. Although a considerable effort has been made to insure that the bibliography is complete, readers are encouraged to bring any omissions to the attention of this Center.

The Technology Application Center is one of six Industrial Application Centers established by NASA's Technology Utilization Program to evaluate and disseminate new technology to the general public and commercial business.

(NASA-CR-158634) HYDROGEN ENERGY. A BIBLIOGRAPHY WITH ABSTRACTS Quarterly Report, Jul. - Sep. 1978 (New Mexico Univ.) 52 p

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Space Administration

HYDROGEN ENERGY

A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE

JULY-SEPTEMBER 1978

PREPARED BY THE

ENERGY INFORMATION PROGRAM

of the

TECHNOLOGY APPLICATION CENTER

OCTOBER 1978

THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO

A DIVISION OF THE INSTITUTE FOR APPLIED RESEARCH SERVICES (IARS)

INTRODUCTION

The Hydrogen Energy Bibliography has undergone modifications in formatting effective with the September 30, 1978 quarterly. Changes include the addition of a new section on Materials and the generalization of all subsections which were previously too specific.

Materials were previously included as a subsection of Safety but the large number of Materials citations that were not Safety related necessitated the creation of this new section.

Subsection headings were made more general because previous headings were overly specific, resulting in no citations for specific headings and a large number of citations in the "general" and "other" headings. An effort was made to achieve an optimal balance between being too specific and too general.

Continuity has been maintained in the numbering of sections and the duplication of citation numbers from previous quarterlies was avoided.

Changes were made to facilitate the use of the Hydrogen Energy Update. The user's comments and criticisms are welcomed.

David D. Kenney
Technical Editor

GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

-- A TABLE OF CONTENTS listing general categories of subject content and indexes. More specific coverage by subject title/keyword and author is available through the appropriate index.

-- CITATION NUMBERS assigned to each reference. These numbers, with the prefix omitted, are used instead of page numbers to identify references in the various indexes. They are also used as TAC identifier numbers when dealing with document orders; so please use the entire (prefix included) citation number when corresponding with TAC regarding a reference. An open ended numbering system facilitates easy incorporation of subsequent updates into the organization of the material. In this system, numbers assigned to new citations in each category will follow directly the last assigned numbers in the previous publication. The citation number of the last reference on each page appears on the upper right-hand corner of that page to facilitate quick location of a specific term.

-- A REFERENCE FORMAT containing the TAC citation number, title of reference, author, corporate affiliation, reference source, contract or grant number, abstract and keywords. The reference source tells, to the best of our knowledge, where the reference came from. If from a periodical, the reference source contains the periodical's title, volume number, page number and date. If for a report, the reference source contains the report number assigned by the issuing agency, number of pages and date.

-- An INDEX OF AUTHORS alphabetized by author's last name. A reference's author is followed by the reference's citation number. For multiple authors, each author is listed in the index.

-- An INDEX OF PERMUTED TITLES/KEYWORDS affords access through major words in the title and through an assigned set of keywords for each citation. A reference's title is followed by the reference's citation number. In the indexes, all the words pertaining to a reference are permuted alphabetically. Thus, the citation number for a reference appears as many times as there are major title words or keywords for that reference. The permuted words run down the center of an index page. The rest of the title or keywords appear adjacent to a permuted word. Since a title or set of keywords is allowed only one line per permuted word the beginning, the end, or both ends of a title or set of keywords may be cut off; or, if space permits, it will be continued at the opposite side of the page until it runs back into itself. A ‡ indicates the end of a title or set of keywords while a / indicates where a title or set of keywords has been cut off within a line.

CONTENTS

*No citations recovered for this category.
**Citation numbers appear on upper right corner of each page

10000 I. GENERAL

H78 10041 AMERICAN CHEMICAL SOCIETY, DIVISION OF FUEL CHEMISTRY, PREPRINTS, Volume 21, No. 1: SYMPOSIUM ON HEAVY FUEL OIL ADDITIVES, SYMPOSIUM ON AMMONIA FEEDSTOCKS SUPPLY, SYMPOSIUM ON FUELS FROM WASTES, Volume 21, No. 2: SYMPOSIUM ON NET ENERGETICS OF INTEGRATED SYNFUEL SYSTEMS, Volume 21, No. 3: SYMPOSIUM ON THERMOCHEMICAL GENERATION OF HYDROGEN, 1976

Anon., (Am. Chem. Soc., Washington, D.C.), Am. Chem. Soc. Div. Fuel Chem. Prepr., V 21: N1-3, 171st Nat'l Mtg., New York, NY, April 5-9, 1976
No abstract available.

H78 10042 BSC PLOTS POSSIBLE ENERGY "ROUTES" PAST THE END OF THE TWENTIETH CENTURY

Anon., 33 Mag. Met. Prod., V 14:38-41, N5, May 1976
No abstract available.

H78 10043 POWER SOURCES SYMPOSIUM, 26th, Proceedings, 1974

Anon., Power Sources 26th Symp. Proc., Paper, 197 p., April 29-30 and May 1-2, 1974, Ill. Inst. of Tech., Chicago, IL, Publ. by PSC Publ. Comm., Red Bank, NJ, 1974
No abstract available.

H78 10044 WHAT CAN HYDROGEN DO FOR AN ENERGY COMPANY?

Casazza, J.A., (Public Serv. Electric and Gas Co.), Combustion, V 47:23-27, N11, May 1976, J76-0053094
No abstract available.

H78 10045 HYDROGEN ENERGY TASK FORCE REPORT OF THE WORKSHOP ON HYDROGEN ENERGY, July 13-14, 1977, Dept. of Sci. and Tech., New Delhi, India

R78-0042707
A task force was formed to prepare a viable action plan for development of hydrogen energy as best suited to the needs and conditions of India. Results are given from working groups on: production of hydrogen; storage, transmission, and utilization of hydrogen; and power systems, transduction, and technoeconomic aspects. The following production processes were considered: coal gasification, water electrolysis, thermochemical reaction cycles, photolysis and photoassisted electrolysis utilizing solar energy, photo-biosynthetic methods, and microbiological methods. Storage systems considered are hydride and cryogenic systems.

H78 10046 PICTORIAL OVERVIEW OF THE HYDROGEN-ENERGY CONCEPT

Escher, W., (Escher Tech. Assoc., St. Johns, MI), Energy Res. and Dev'ment 5th Annual Symp., March 13-14, 1974, Washington, D.C., Spons. by Am. Def. Prep. Assoc. Paper, p. 80-89, Publ. by Edgewood Arsenal, Aberdeen Proving Ground, MD, Jan. 1975, R76-0044962
Avail:NTIS
No abstract available.

H78 10047 PRESENT AND FUTURE ABOUT HYDROGEN IN 1977

Galland, J., Hydrogen in Metals, V 1, Pergamon Press, Ltd., Elmsford, NY, 1977, In French
Present and future utilizations of hydrogen are mentioned; problems about different possibilities of hydrogen production and storage, especially hydride formation and decomposition are also studied.

H78 10048 FUTURE OF HYDROGEN IN THE GAS INDUSTRY

Gregory, D.P., (Inst. of Gas Tech., Chicago, IL), Proc. of 1st Int. Energy Agency Water Electrolysis Workshop, 1975, 78C0035911
The following topics are discussed: some industrial and government opinions about hydrogen as an energy medium; gas industry and opportunities; and required thrust of a gas industry R and D program on hydrogen.

H78 10049 WASSERSTOFF--BRENNSTOFF DER ZUKUNFT, (HYDROGEN--A FUEL FOR THE FUTURE)

Gregory, D.P., (Energy Syst. Res. Inst. of Gas Tech., Chicago, IL), Gas Waerme Int., V 26:124-134, N3, March 1977, In German with English summary
No abstract available.

H78 10050 HYDROGEN-ENERGY TECHNOLOGY, TODAY AND TOMORROW

Gregory, D.P., (Inst. of Gas Tech., Chicago, IL), Energy Tech. 2nd Conf. Proc., May 12-14, 1975, p. 234-241, Washington, D.C., Publ. by Govt. Inst., Inc., Washington, D.C., 1975 R76-0023339
No abstract available.

H78 10051 SURVEY OF HYDROGEN PRODUCTION AND UTILIZATION METHODS

Gregory, D.D., (Inst. of Gas Tech., Chicago, IL), Spons. by NASA, Oct. 16, 1974 - Aug. 15, 1975, 00X0001856

The objectives of this study are: (1) to survey and evaluate methods of producing large quantities of hydrogen from several different energy sources; (2) to identify present and future uses of hydrogen in the industrial and residential sectors; (3) to provide cost estimates for developing the technologies required for large-scale production; and (4) to recommend a series of follow-on steps (studies, development programs) to be carried out during the next five years that would lead to the use of hydrogen as a major energy carrier. Guidelines and constraints: (1) the production of hydrogen from natural gas or petroleum products will be included for completeness under this work statement; (2) production of hydrogen from coal gasification will also be included. A great deal of work is being done by other agencies in this field (coal gasification) and maximum use will be made of their work; (3) thermochemical processes for hydrogen production should be compatible with the maximum operating temperature of nuclear reactors and compatible with containment and structural materials in solar energy systems; and (4) in the initial phases of this program, no effort will be expended on the study of hydrogen-fueled aircraft or hydrogen-fueled surface vehicles. However, the impact of hydrogen on the production of synthetic fuels for the transportation sector will be examined.

H78 10052 HYDROGEN PROBLEMS IN ENERGY RELATED TECHNOLOGY

Hirth, J.P., Johnson, H.H., (Ohio State Univ., Columbus, OH), Corrosion, V 32:3-26, N1, Jan. 1976, J76-0025438
No abstract available.

H78 10053 FUTURE OF HYDROGEN IN TEXAS' ENERGY MARKETS

Huang, C.J., (University of Houston, Houston, TX), July 1974-Feb. 1975

The questions for assessing hydrogen use in Texas which are to be answered are these: (1) what will the cost of hydrogen be relative to other energy forms in the coming 10-year period? (2) How can hydrogen be phased into the economy of Texas without disruption of existing energy systems? How much of the existing pipeline network can be used in a hydrogen system? (3) Assuming hydrogen to be used in all feasible ways to replace fossil fuels, what savings in fossil fuels will result? (4) What research is needed to fully determine the feasibility of implementing a hydrogen energy system in Texas? These questions should be answered by examining hydrogen production methods using resources such as lignite available in Texas, and the cost of producing hydrogen by these methods. The research necessary to fully implement the hydrogen system will be determined by examining the lowest cost production, distribution, and usage systems that can be applied in Texas, and identifying the parts of this system which are not as yet technically proven.

H78 10054 HYDROGEN ENERGY: CHEMICAL PROBLEMS INVOLVED

Kotera, Y., (Army Foreign Sci. and Tech. Center, Charlottesville, VA), Denki Kagaku Oyobi Kogyu Butsuri Kagaku, Japan, (Engl. Trans.), V 42:25, N7, July 1974, X77-72295
No abstract available.

H78 10055 PROCEEDINGS OF THE CORNELL INTERNATIONAL SYMPOSIUM AND WORKSHOP ON THE HYDROGEN ECONOMY

Linke, S., (Cornell Univ., Ithaca, NY), Spons. by NSF, 443 p., Aug. 20-22, 1973, N76-15611 $11.75
Avail:NTIS

This document contains the proceedings of a symposium on the hydrogen energy economy conducted at Cornell University in August, 1973. The participants included both advocates and skeptics, so that the principles in each camp would have direct intellectual contact in order to achieve a better understanding of the potential of the hydrogen economy, either pro or con. Both view points are amply represented in these proceedings. Alternate proposals such as the all-electric economy and the methanol economy are also included. The issue of hydrogen economics remains uncertain despite the attention given it during the conference, but the continuing high cost of fossil fuels will make hydrogen economically feasible sooner than any participant would have dared to predict in 1973. Subjects covered here include the following: an overview of the hydrogen economy, hydrogen production and economics, energy transmission and storage, thermochemical means of producing hydrogen, electrochemical problems of the hydrogen economy, hydrogen in the marketplace, prospects for hydrogen utilization, and the impact of hydrogen on transportation.

H78 10056 HYDROGEN AND NUCLEAR POWER

Lucas, N., (Imp. Coll. of Sci and Tech., London, England), Energy Policy, V 4:25-36, N1, March 1976, J77-0011480
No abstract available.

H78 10057 HYDROGEN: MECHANISMS AND STRATEGIES OF MARKET PENETRATION

Manne, A.S., Marchetti, C., (Int. Inst. for Appl. Systems Analysis, Laxenburg, Austria), Hydrogen Economy Miami Energy Conf. Proc., Miami Beach, FL, March 18-20, 1974, Pt. B, p. 1193-1208, Publ. by Plenum Press, New York, NY, 1975, R76-0010128
No abstract available.

H78 10058 HYDROGEN AS A FUEL

McAlevy, R.F.III, Weil, K.H., Cole, R.B., (US Dept. of Defense, Defense Advanced Res. Projects Agency, Public Service Electr. and Gas Co., Stevens Inst. of Tech.), Jan. 1974-Sept. 1975
This is an engineering study of the technical problems expected with the large-scale introduction of H_2 as a fuel. It includes H_2 generation, transportation and utilization as an engine fuel. Generation by coal gasification, electrolysis, and thermochemical processes using nuclear heat sources was investigated; preliminary conclusions have been drawn. Transmission by pipelines might be limited by the inability of existing pipeline compressors to meet economically the expected demands of H_2; a novel, "regenerative," compressor has been proposed. Fundamental relationships between fuel properties and reciprocating engine performance parameters were established and are used to form a rational basis for evaluating H_2 (vs. hydrocarbons) as air engine fuel. An extensive review of published results revealed that H_2 was capable of highly efficient, low-pollution operation of such engines when fuel-loan mixtures were used. Work on the storage of H_2 and its use as a gas turbine fuel is underway.

H78 10059 NEW TECHNOLOGIES FOR CHEMICAL FUELS AND THEIR PROBLEMS

Morita, Y., Sekiyu Gakkaishi, V 18:725-731, N9, Sept. 1976, In Japanese, J78-0019933
A discussion on current fuel-related research and development and the prospects of commercial solutions covers motor fuels, including unleaded gasoline, engine modifications, and automotive exhaust purification; production of fuel oil by thermal and catalytic cracking, hydrocracking, and direct desulferization of fuel oil; gasification of residual oils by thermal cracking, high temperature partial oxidation, hydrocracking, and catalytic gasification; coal gasification processes; coal liquefaction processes; hydrogen fuel cells; the production of synthetic natural gas and of ethane-rich gas; and production of coke and other solid coal products.

H78 10060 COST AND AVAILABILITY OF HYDROGEN

Parrish, W.R., Voth, R.O., (NBS, Inst. for Basic Stand, Boulder, CO), Nat'l Bureau Stand. Spec. Publ., N 419, Pap 1, 26 p., May 1975, J76-0031693
No abstract available.

H78 10061 ENERGY MANAGEMENT

Peterson, W.J., Cunnington, G.R., Atherton, L.F., Streed, E.R., (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Inc., Sunnyvale, CA), July 1971-continuing
The approach used was to first establish the energy requirements of moderately sized military bases, housing complexes, and shopping centers. Completion of these studies on a number of specific complexes, with variable weather, variable heating and cooling requirements, and variable existing or as yet undeveloped energy sources would furnish the information required for sizing of the energy supply system and for defining critical needs in hardware and technology. The steps to be followed for each of the potential energy sources were as follows: solar energy--determine the role of solar energy in space heating, water heating, conversion to electrical energy, and air conditioning. Select two or three potential applications of solar energy and perform a thermodynamic analysis sufficient to prepare a conceptual design. Perform a parametric study of the performance

tradeoffs to derive economic factors for comparison with other fuels for future use. Identify the physical problems associated with the burning of hydrogen and seek possible solutions. Solid waste--identify the various forms of solid waste that can be utilized for fuel. Identify the problems associated with using solid waste as a fuel, including the material and pollution problems. Perform studies to obtain the economic data necessary for comparison with other systems.

H78 10062 HYDROGEN ENERGY

Veziroglu, T.N., (Univ. of Miami, Clean Energy Res. Inst., Coral Gables, FL), March 1973-March 1975, X00-0001922
Avail:NSF

As an answer to the problems of growing fuel demand, pollution and the depletion of fossil fuels, the replacement of fossil fuels by hydrogen has been investigated. It has been shown that this could be a solution to the above problems. Using transmission, storage, and distribution methods presently in use by the natural gas industry, as well as innovative techniques to be developed, hydrogen offers itself as an excellent fuel. It can be broadly utilized as such in lieu of the fossil fuels. Being the cleanest possible fuel, hydrogen also offers significant environmental benefits. In connection with these studies, the Hydrogen Economy Miami Energy (Theme) Conference has been conducted. In the conference, some 90 papers have been presented covering the production, transmission, and storage and utilization of hydrogen. Formal confidence proceedings are published by Plenum Publishing Corporation.

20000 II. PRODUCTION

H78 20011 INDUSTRIAL STATIONARY BATTERIES

Abbott, T., (ESB, Inc., Philadelphia, PA), Plant Engng., Barrington, IL, V 29:57-58, N11, May 29, 1975, J78-0008800

The factors influencing the installation and use of stationary batteries are reviewed. The influence of altitude and temperature on such things as hydrogen evolution and the consequent increase in importance of adequate ventilation are stressed. The best planning approach to a stationary industrial battery system treats the installation as a unified whole.

H78 20012 ASSESSMENT OF METHODS FOR DIRECT CONVERSION OF AGRICULTURAL RESIDUES TO UTILIZABLE ENERGY FORMS

Bailie, R.C., Carns, H.R., (Univ. of W. Virginia, Morgantown, WV), June 18, 1975-Sept. 17, 1976

This report provides a technical and economic assessment of conversion systems which may be used to convert agricultural residues to fuel for single farms or small agricultural communities. This is a state-of-the-art evaluation to be based on existing data for the various processes and will include an analysis of the energy efficiency of each process alone, as well as the direct and indirect input. Processes to be evaluated will include direct combustion, anaerobic digestion, both thermophilic and mesophilic, for the production of methanes and alcohols, pyrolysis-complete and partial, chemical reduction, hydro-gasification, catalytic gasification, enzymatic reduction, and combined hydrolysis fermentation.

H78 20013 ELECTROCHEMICAL CONVERSION OF ANIMAL WASTES INTO PROTEIN AND HYDROGEN

Day, D.L., Steinberg, M.P., (Univ. of Illinois, Urbana, IL), Agri Engng., Jan. 1977-Sept. 30, 1978

This report investigates the technical feasibility of replacing mechanical aeration with electrochemical oxidation of livestock wastes to produce feed protein and by-product hydrogen. Upgrading the nitrogen to protein is of special importance for refeeding to nonruminants as an alternative to spreading wastes on land while achieving pollution control. Initial studies will use a laboratory bench scale electrolytic cell wherein liquid swine manure will serve as the electrolyte. Aerobic bacteria will utilize oxygen as it is produced at the anode and hydrogen, a potential fuel of the future, will be produced at the anode. Low voltage direct current electricity will run the apparatus. Technical operational parameters will be studied to achieve optimum growth of single-cell protein and production of hydrogen.

H78 20014 MANUFACTURE OF HYDROGEN AND OXYGEN FOR FUEL

Lee, R.A., (Texas Gas Transmission Corp.), Ger. Offen., 13 p., Publ. Dec. 15, 1977

No abstract available.

H78 20015 WORK FUNCTION DEPENDENCE AND ISOTOPE EFFECT IN THE PRODUCTION OF NEGATIVE HYDROGEN IONS DURING SPUTTERING OF ADSORBED HYDROGEN ON CS-COVERED Mo(100) SURFACES

Yu, M.L., (Brookhaven Nat'l Lab., Upton, NY, Dept. of Energy), Contract no. EY-76-C-02-0016 1977

The enhancement of the H^- yield, during sputtering of adsorbed hydrogen on a Mo (100) surface, by a Cs overlayer was investigated. An exponential dependence of the H^- yield on the work function was observed for a wide range of Cs coverages. A simple electron tunneling model was proposed. A large reduction in the ion yield was also observed when D_2 replaced H_2 as the adsorbate.

H78 21021 ELECTROLYTIC HYDROGEN FOR AMMONIA SYNTHESIS

Anon., Nitrogen, England, Series 97, p. 35-40, 1975

No abstract available.

H78 21022 PSE AND G INTEREST IN THE ELECTROLYTIC PRODUCTION OF HYDROGEN

Burger, J.M., Proc. of 1st Int. Energy Agency Water Electrolysis Workshop, 1975, BNL-21165
Use of hydrogen as an energy storage medium is discussed. One approach entails the electrolysis of water with off-peak electricity to produce hydrogen which would be stored probably as a gas or metal hydride, the stored hydrogen would be withdrawn at peak demand periods as a fuel for a gas turbine or a fuel cell.

H78 21023 PERSPECTIVES DE PRODUCTION MASSIVE D'HYDROGENE PAR ELECTROLYSE, (PROSPECTS OF LARGE-SCALE HYDROGEN PRODUCTION BY ELECTROLYSIS)

Godin, P., (Electr. de Fr.), Rev. Gen. Electr., V 85:530-533, N6, June 1976, In French
No abstract available.

H78 21024 ELECTROLYSIS BASED HYDROGEN STORAGE SYSTEMS, Annual Report, Jan. 1, 1976-Dec. 31, 1976

Salzano, F.J., (Brookhaven Nat'l Lab., Upton, NY, Dept. of Energy), Contract no. EY-76-C-02-0016, 131 p., Jan. 1977
This report describes work completed during the period January 1, 1976 to December 31, 1976, on an ERDA-sponsored program aimed at improvement in the cost and efficiency of electrolytic hydrogen production and development of the technique of using metal hydrides for hydrogen storage for stationary and transportation applications. The work on electrolytic hydrogen production includes work on advanced barrier materials for alkaline cells, studies of nickel alloy based and oxide catalysts for oxygen evolution. Related work on the program involving the H_2-Cl_2 electrochemical cell for energy storage is described. Work on hydrogen storage subsystems involving storage reservoir designs for the Hydrogen Technology Advanced-Component Test System (HYTACTS), engineering and metal hydride material test beds and tests of candidate container materials is presented. Progress on the development of new metal hydride materials and tailoring and testing of new alloy systems is summarized. This work emphasizes improvement in the initial activation step, high-cycle test of selected materials and the physical characteristics of cycled materials. The efforts on natural gas supplementation, hydrogen storage systems analysis and the project management of the ERDA Hydrogen Program by BNL are summarized.

H78 21025 WATER ELECTROLYSIS UNDER ATMOSPHERIC PRESSURE, (L'ELECTROLYSE DE L'EAU A LA PRESSION ATMOSPHERIQUE EN PRENANT COMME EXEMPLE L'ELECTROLYSEUR BBC)

Vuilleumier, H.M., Braun, M., (Soc. Brown Boveri), Rev. Gen. Electr., V 85:534-536, N6, June 1976, In French, Card Alert 083005
No abstract available.

H78 21026 WATER ELECTROLYSIS UNDER PRESSURE, (ELECTROLYSE SOUS PRESSION DE L'EAU)

Wuellenweber, H., (Soc. Lurgi, Frankfurt Am., Germany), Rev. Gen. Electr., V 85:537-541, N6, June 1976, Card Alert 083006
No abstract available.

H78 22020 THERMOCHEMICAL PROCESSES FOR HYDROGEN PRODUCTION BY WATER DECOMPOSITION

(Univ. of Pennsylvania, Philadelphia, PA), MOD A001 CN-EY-76-S-02-2747
No abstract available.

H78 22021 ISPRA MARK-10 WATER SPLITTING PROCESS

(General Atomic Co., San Diego, CA), Studies of the use of High-Temp. Nucl. Heat from an HTGR for Hydrogen Production, 52 p., N76-15580
A thermochemical water splitting process, the Ispra Mark-10 Chemical Reaction Cycle, was chosen for examining the possibility of using water to produce hydrogen on a large scale for fuel and major industrial chemical uses. The assumed energy source for the process is an HTGR (helium cooled). A process flow diagram, a material balance, and an energy balance were developed for the thermochemical reaction cycle. Principal reactions which constitute the cycle are included.

H78 22022 NUCLEAR WATER SPLITTING AND HIGH TEMPERATURE REACTORS

Barnert, H., Schulten, R., (Nucl. Res. Cent., Juelich, Germany), Hydrogen Econ. Miami Energy Conf., Proc. Miami Beach, FL, March 18-20, 1974, Pt. A, p. 115-128, Publ. by Plenum Press, New York, NY, 1975, R76-0010133
No abstract available.

H78 22023 MANUFACTURE OF HYDROGEN AND OXYGEN FROM WATER USING THE HEAT FROM NUCLEAR POWER INSTALLATIONS

Frie, W., Ger. Offen., 15 p., Publ. March 9, 1978, Patent no. 2639624, Applic. no. 2639624, Applic. on Sept. 2, 1976
No abstract available.

H78 22024 THERMOCHEMICAL PROCESSES FOR THE PRODUCTION OF HYDROGEN FROM WATER

Funk, J.E., (Coll. Engng., Univ. of Kentucky, Lexington, KY), Am. Chem. Soc., Div. Fuel Chem., Prepr., Issue 3, p. 1-9, series 21, 1976
No abstract available.

H78 22025 STUDIES ON THERMOCHEMICAL HYDROGEN PRODUCTION, I. THE EVOLUTION OF HYDROGEN AND IODINE BY THE DECOMPOSITION OF AMMONIUM IODIDE AND HYDROGEN IODIDE

Ishikawa, H., Nakane, M., Ishii, E., Uehara, I., Miyake, Y., (Gov. Ind. Res. Inst., Ikeda, Japan), Nippon Kagaku Kaishi, N10, p. 1457-1461, 1977, In Japanese
No abstract available.

H78 22026 STUDIES ON THERMOCHEMICAL HYDROGEN PRODUCTION, III. THE HYDROLYSIS OF IRON(II) BROMIDE

Ishikawa, H., Ishii, E., Uehara, I., Nakane, M., Miyake, Y., (Gov. Ind. Res. Inst., Ikeda, Japan), Nippon Kagaku Kaishi, N4, p. 530-534, 1978, In Japanese
No abstract available.

H78 22027 ECONOMIC CRITERIA OF SELECTION FOR CLOSED CYCLE THERMOCHEMICAL WATER SPLITTING PROCESSES

Joly, F., (Pechiney Ugine Kuhlmann, Paris, France), Hydrogen Econ. Miami Energy Conf. Proc. Miami Beach, FL, March 18-20, 1974, Pt. A, p. 279-289, Publ. by Plenum Press, New York, NY 1975, R76-0010134, Card Alert 011489
No abstract available.

H78 22028 HYBRID PROCESS FOR THERMOCHEMICAL PRODUCTION OF HYDROGEN

Miura, N., Tokunaga, K., Harada, T., Yamazoe, N., Seiyama, T., (Kyushu Univ., Fac. Engng., Dept. Mat. Sci and Tech., Fukuoka, Japan), Denki Kagaku, V 46:113-117, N2, 1978, SB-I
No abstract available.

H78 22029 STUDY ON KEY REACTIONS OF THERMOCHEMICAL PRODUCTION OF HYDROGEN USING IRON-CHLORINE CYCLES

Miura, N., Tokunaga, K., Yamazoe, N., Seiyama, T., (Kyushu Univ., Fac. Engng., Dept. Mat. Sci. and Tech., Fukuoka, Japan), Denki Kagaku, V 46:95-99, N2, 1978
No abstract available.

H78 22030 INVESTIGATION OF SULFUR BASED THERMOCHEMICAL CYCLES FOR HYDROGEN PRODUCTION BY WATER DECOMPOSITION

Natarajan, M., (Univ. of New Mexico, Albuquerque, NM), Diss. Abstract Int. B, V 38:177, N2, 1977.
Avail:Microfilms Int., Order no. 77-16, 110
No abstract available.

H78 23005 COAL GASIFICATION

Baron, G., Tanz, H., (Lurgi Mineraloeltechnik GMBH, Frankfurt Am Main, Germany F.R.), Bieger, F., Lohmann, C., (Ruhrgas A.G., Dorsten, Germany, F.R.), Cornils, B., Traenckner, K.C., (Ruhrchemie A.G., Oberhausen, Germany, F.R.), Franzen, J.E., Goeke, E.K., (Krupp-Koppers GMBH, Essen, Germany, F.R.), Chemierohstoffe Aus Kohle, Thieme, Stuttgart, Germany, F.R., 1977, In German, Y78-0041876

The conversion of pit coal or brown coal with gasification agents (coal gasification) is discussed in detail. Under the title "Production of Synthesis Gas," the physical-chemical basics, the various technical gasification processes, gas purification, and in separate chapters, the production of hydrogen and carbon monoxide.

H78 23006 COKE GASIFICATION DEMONSTRATION

Crowley, D.M., (Koppers Co., Inc., Engng. and Construction Div., Pittsburgh, PA), Koppers Co., Inc., Oil companies unspec. (Spons.), October 1974-March 1975

This program involves a commercial demonstration of gasifying petroleum derived cokes in a Koppers-Totzek gasifier. The K-T process is a commercially proven coal gasification process. Potentially, it could be used to generate either fuel gas or hydrogen from byproduct coke which has no ready outlet if it contains significant amounts of sulfur and metals. The purpose of the program is to demonstrate operability of the gasifier on this type of feedstock.

H78 23007 DEVELOPMENT OF THE STEAM IRON PROCESS FOR HYDROGEN PRODUCTION, Project 9010 Quarterly Report No. 2, October 1-December 31, 1976

(Inst. of Gas Tech., Chicago, IL, Dept. of Energy), Oct. 1977, 72 p., contract no. EX-76-C-01-2435
Avail:NTIS

Status of the operational evaluation of the steam-iron pilot plant for hydrogen production and related supporting research studies is reported. The overall program plan has been divided into seven tasks: reactor system start-up, reactor system variables study, design of static blade test equipment, kinetic studies, char evaluation, attrition studies, and lift-line studies. The objective of Task 1 is to achieve controlled operation of the producer and the steam-iron reactors. Two solids-circulation tests were conducted in the steam-iron reactor. Sixteen reactivity and 15 attrition tests were conducted. None of the materials tested displayed a significantly better combination of reactivity and attrition resistance than the siderite ore now being used in the pilot plant. The objective of Task 5 is to test chars for future use in the producer reactor for the steam-iron process. Ten tests were conducted with Montana subbituminous char. The objective of Task 6 is to determine the attrition characteristics of siderite ore and char. Two tests were conducted with -80+100 mesh siderite to determine the effect of gas density on the attrition characteristics of siderite. The objectives of Task 7 are to determine the flow characteristics of the dense-phase lift and the acceleration zone--the transition zone between the dense and the lean-phase lifts. Existing equipment was modified during the previous quarter for carrying out the experiments. Thirteen tests were conducted during the present quarter.

H78 23008 PRODUCTION OF AMMONIA USING COAL AS A SOURCE OF HYDROGEN

Laukhuf, W.L.S., (Univ. of Kentucky, Lexington, KY), 1977, B78-0056914

A study was performed to determine an optimum set of operating conditions for a coal gasifier used to provide hydrogen for a 1200-ton per day ammonia synthesis plant. The feedstock was a high-sulfur western Kentucky coal. By using a thermodynamic equilibrium model of a gasifier, it was found that if more steam was sent to the gasifier and less oxygen or air was sent, more hydrogen would be produced. However, based on the amount of hydrogen produced, no optimum operating conditions were determined. A kinetic model of a fluidized-bed gasifier was developed. Using this model, it was found that less hydrogen is produced in the gasifiers than predicted by the thermodynamic model.

H78 23009 CONVERSION OF AMMONIA INTO HYDROGEN AND NITROGEN BY REACTION WITH A SULFIDED CATALYST

Matthews, C.W., (ERDA, Washington, D.C.), PAT-APPL-685 484, Filed May 11, 1976, patented June 28, 1977, 4 p.

A method is provided for removing ammonia from the sour water stream of a coal gasification process. The basic steps comprise stripping the ammonia from the sour water; heating the stripped ammonia to a temperature from between 400^{o} to 1000^{o} F; passing the gaseous ammonia through a reactor containing a sulfided catalyst to produce elemental hydrogen and nitrogen; and scrubbing the reaction product to obtain an ammonia-free gas. The residual equilibrium ammonia produced by the reactor is recycled into the stripper. The ammonia-free gas may be advantageously treated in a Claus process to recover elemental sulfur. Iron sulfide or cobalt molybdenum sulfide catalysts are used.

H78 23010 COAL CONVERSION

Pollitzer, E.L., (Universal Oil Products Co., Corporate Res. Center, Des Plaines, IL), April 1967-1980

The object is to develop a process for the liquefaction and simultaneous partial gasification of coal. The conversion of coal is accomplished by means of one or more selective solvents operating under hydrogen pressure. The solvents are specially treated fractions of the liquefied coal. Downstream processing of the coal-derived products utilizes processes and catalytic technology petroleum fractions. The ultimate object is the production of fuel gas, raw materials for transportation fuels and low sulfur fuel oil from coal. The unconverted coal is to be used for the generation of the energy and hydrogen required for the process.

H78 23011 HYDROGEN PRODUCTION BY CATALYTIC COAL GASIFICATION

Starkovich, J.A., Blumenthal, J.L., US, 10 p., Publ. Jan. 17, 1978, Patent no. 4069304, Appl. on Dec. 31, 1975, Applic. no. 645858, TRW, INC.
No abstract available.

H78 23012 COAL CONVERSION SYSTEMS TECHNICAL DATA HANDBOOK

Zwolinski, B.J., Wilhoit, R.C., (Texas A and M Univ., College Station, TX, Thermodynamic Res. Center), Spons. by IGT, Chicago, IL, Dec. 1975-Nov. 1976, R78-0001338

To prepare a section or sections on physiochemical properties of certain key organic compounds and gaseous mixtures for use in designing processes to produce clean fuels from coals in two parts: Part I, Thermophysical Properties of Certain Gases, Liquids, and Solids; Part II, PVT and Related Thermodynamic Data on Five Gases (H_2, H_2O, CH_4, CO, and CO_2) together with a proposed program on properties of mixtures of these gases. This will be a subcontract to assist the Institute of Gas Technology to prepare a ten (10) volume set of the ERDA Coal Conversion Systems Technical Data Book.

H78 24001 PHOTOELECTROCHEMICAL PRODUCTION OF HYDROGEN

Bockris, J.O'M., Uosaki, K., (Sch. Phys. Sci., Flinders Univ., S. Australia, Bedford Park, Australia), Adv. Chem. Ser., Solid State Chem. Energy Conversion Storage, Symp., series 163, p. 33-70, 1977
No abstract available.

H78 24002 HYDROGEN PRODUCTION THROUGH SOLAR-RADIATION BY MEANS OF WATER PHOTOLYSIS IN MEMBRANES

Broda, E., (Univ. of Vienna, Inst. Phys. Chem/A-1010, Vienna, Austria), Int. J. of Hydrogen Energy, V 3:119-121, N1, 1978
No abstract available.

H78 24003 HYDROGEN-TRANSFER AND CHARGE-TRANSFER IN PHOTOCHEMICAL REACTIONS, Progress Rept. October 1, 1976-September 30, 1977

Cohen, S.G., (Brandeis Univ., Waltham, MA, Dept. of Energy), Contract no. EY-76-S-02-3118, 12 p., Oct. 1977
Avail:NTIS

Quantitative studies have been made of effects of sulfur compounds on photoreduction of benzophenone by amines. Aromatic mercaptans and disulfides are converted to photostationary equilibrium concentrations of the two forms and retard photoreduction very efficiently, to a small extent by light absorption and quenching of triplet (approximately 10 percent), to a large extent (approximately 60 percent) by the repeated hydrogen transfer reactions, and the remainder by quenching of the charge transfer complex. Aliphatic disulfides are reduced, mercaptans are not oxidized, the two states are not equilibriated, and photoreduction by amines is accelerated by aliphatic mercaptans. The acceleration is attributed to catalysis of proton transfer in the charge-transfer complex. Ratios of rate constants for reduction of amine-derived radicals by mercaptans to oxidation by ketone are obtained. Effects of light absorption, triplet quenching, and hydrogen transfer are calculated in retardation by mercaptans of photoreduction by alcohols. In reduction by 2-propanol and acetophenone, more hydrogen transfer is observed than would be calculated, indicating that thiyl radicals, in addition to ketone triplet, abstract hydrogen. In reduction by benzhydrol, retardation is due entirely to light absorption and quenching. Benzophenone ketyl radical is too highly stabilized for hydrogen abstraction to compete with radical demerization. Rate constants for abstraction of hydrogen from aromatic mercaptans by the ketyl radicals are estimated. In photoreduction of fluorenone by substituted dimethylanilines, low quantum yield due to an electron donating substituent is increased by decrease in polarity of solvent, and low quantum yield due to electron withdrawing substituents is increased by increase in polarity of solvent. The results are attributed to effects of substituents and solvent polarity on extent of charge transfer in the charge transfer complex.

H78 24004 STEAM-IRON PROCESS FOR PRODUCTION OF HYDROGEN

Das, A., Chatterjee, D.S., Mukherjee, P.N., (Cent. Fuel Res. Inst., Dhanbad, India), Ind. J. of Tech., V 15:339-341, N8, 1977
No abstract available.

H78 24005 PROMISING RESULTS FROM A.N.U. SOLAR AMMONIA SYSTEM

Energy, Australia, V 4:12-15, N3, March 1977, J78-0001698

The solar ammonia system has potential as an alternative, rather than a supplement, to fossil fuels. The essential elements of the system are a system of paraboloidal mirrors which track the sun. Solar energy is reflected to the focal points of the mirrors. At the focal point, a focal absorber dissociates ammonia under high pressure into a mixture of nitrogen and hydrogen at about 700 C. This mixture is then piped under high pressure in small diameter pipes to a central station where solar energy is recovered as heat by reversal of the chemical change in a synthesizer using an alumina/nickel catalyst. The heat energy output may then be used for steam to generate electricity or as high temperature heat for other processes. Alternatively, the nitrogen/hydrogen mixture may be stored for later reconversion. The system uses a heat exchanger in conjunction with the focal absorber to pre-heat incoming ammonia and cool the outflowing gas mixture. The system operates as a closed loop with the nitrogen and hydrogen reactants recirculating as ammonia. Cost calculations show that electricity produced by the system can now be competitive with electricity produced from present fuels. The minimum viable plant size is about 10 million watts, applicable to a remote township.

H78 24006 OCEAN BASED SOLAR-TO-HYDROGEN ENERGY CONVERSION MACRO SYSTEM

Escher, W.J.D., Hanson, J.A., (Escher Tech. Assoc., St. Johns, MI), Hydrogen Econ. Miami Energy Conf. Proc., Miami Beach, FL, March 18-20, 1974, Pt. A, p. 209-229, Publ. by Plenum Press, New York, NY, 1975, R76-0013158

No abstract available.

H78 24007 THE CHARACTERIZATION OF A LASER-PRODUCED NEGATIVE-HYDROGEN-ION PLASMA

Gekelman, W., Vanek, V., Wong., A.Y., (TRW Systems Group, Redondo Beach, CA), J. Appl. Phys., V 49:3049-3058, N6, June 1978

The parameters of a plasma produced by irradiation of alkali hydride targets with a ruby-laser pulse are experimentally measured. Positive and negative-ion abundances are determined with a quadrupole mass analyzer. Electron temperature was measured with rapidly swept Langmuir probes. Negative (HSUP(-)) ion temperature was obtained using the mass analyzer and focusing grids. The electron density near the target was determined by optical holography. The quantity of negative ions produced per laser pulse makes the source attractive for the future development of high-energy neutral-beam systems.

H78 24008 HYDROGEN-PRODUCING BACTERIA IN ANAEROBIC WASTE TREATMENT

Holmes, P.E., (N. Dakota State Univ., Fargo, ND), Dec. 16, 1975-Sept. 30, 1980

The isolation and description of hydrogen (H_2)-producing bacteria in a municipal anaerobic sewage sludge digester was started. Preliminary results indicated that a number of organic compounds supported growth and H_2 production by digester bacteria. These included glucose, fructose, maltose, sucrose, casamino acids, glutamate, and serine. A number of bacteria were isolated on other compounds but failed to grow in subcultures. Clarified digester liquor affected the amount of H_2 produced by cultures. The effect was stimulatory, inhibitory, or negligible, depending on the isolate.

H78 24009 HIGH TEMPERATURE BLANKETS FOR THE PRODUCTION OF SYNTHETIC FUELS

Powell, J.R., Steinberg, M., Fillo, J., Makowitz, H., (Brookhaven Nat'l Lab., Upton, NY, Dept. of Energy), Contract no. EY-76-C-02-0016, Symp. on Fusion Res. Project, Knoxville, TN, Oct. 25, 1977

The application of very high temperature blankets to improved efficiency of electric power generation and production of H_2 and H_2-based synthetic fuels is described. The blanket modules have a low temperature (300 to 400 C) structure (SS, V, Al, etc.) which serves as the vacuum/coolant pressure boundary, and a hot (1000 C) thermally insulated interior. Approximately 50 to 70 percent of the fusion energy is deposited in the hot interior because of deep penetration by high energy neutrons. Separate coolant circuits are used for the two temperature zones: water for the low-temperature structure, and steam or He for the hot interior. Electric generation efficiencies of approximately 60 percent and H_2 production efficiencies of approximately 50 to 70 percent, depending on design, are projected for fusion reactors using these high-temperature blankets.

H78 24010 EXCITED HYDROGEN AND ARGON ATOM PRODUCTION BY CHARGE TRANSFER OF METASTABLE Ar^+ IONS IN H_2 MOLECULES

Rothwell, H.L.Jr., Amme, R.C.Jr., Van Zyl, B.Jr., (Dept. of Physics, Univ. of Denver, Denver, CO), J. Chem. Phys., V 68:4326-4327, N9, May 1, 1978, CPM: 7807-A-0416

Observations of excited products from charge-transfering collisional between Ar ions and molecular hydrogen are reported.

H78 24011 PHOTO-ENHANCED PRODUCTION OF HYDROGEN BY LIQUID-PHASE CATALYTIC DEHYDROGENATION OF PROPAN-2-OL WITH RHODIUM-TIN CHLORIDE COMPLEXES

Shinoda, S., Moriyama, H., Kise, Y., Saito, Y., (Univ. of Tokyo, Inst. Ind. Sci., Minato Ku, Tokyo Japan), J. Chem. Soc.-Chem. Commun., V 5:348-349, N8, 1978

No abstract available.

H78 24012 PRODUCTION OF HYDROGEN BY ULTRAVIOLET IRRADIATION OF BINUCLEAR MOLYBDENUM(II) COMPLEXES IN ACIDIC AQUEOUS SOLUTIONS; OBSERVATION OF MOLYBDENUM HYDRIDE INTERMEDIATES IN OCTAHALODIMOLYBDATE(II) PHOTOREACTIONS

Trogler, W.C., Erwin, D.K., Geoffroy, G.L., Gray, H.B., (Arthur Amos Noyes Lab. Chem. Phys., California Inst. Tech., Pasadena, CA), J. Am. Chem. Soc., N4, p. 1160-1163, series 100, 1978

No abstract available.

H78 24013 SPONTANEOUS EXPLOSIONS IN MULTIATMOSPHERE H_2-F_2-O_2 MIXTURES

Truby, F.K., (Sandia Labs., Albuquerque, NM), J. Appl. Phys., V 49:3481-3484, N6, June 1978, CPM 7807-B-0471

Explosion studies in multiatmosphere H_2-F_2-O_2 mixtures show that the pressure at which such mixtures spontaneously explode are greatly affected by treatment of the explosion cell surfaces prior to filling the cell with H_2-F_2-O_2 mixtures. This strong effect of surface conditioning indicates that the observed explosions in H_2-F_2-O_2 mixtures (covering a wide range in F_2/H_2 ratios) with total pressures up to 10 atm result from surface-associated initiation processes, rather than from purely volume-initiated third-limit processes. These results agree with a kinetic model involving H_2O_2 production with a chain formation of H_2O at the surface.

H78 24014 ANAEROBIC GROWTH OF A RHODOPSEUDOMAS SPECIES IN THE DARK WITH CARBON MONOXIDE AS A SOLE CARBON AND ENERGY SUBSTRATE, Proc.

Uffen, R.L., (Microbiology and Public Health, Michigan State Univ., E. Lansing, MI), July 1, 1972 to June 30, 1977

Certain anoxygenic phototrophic bacteria grew in anaerobic dark conditions and produced copious amounts of hydrogen gas. Two microorganisms that exhibited this property are being studied. During anaerobic dark growth Thodospirillum rubrum mutant C fermented Na-pyruvate and produced H_2 from Na-formate by a CO-sensitive formic hydrogenlyase reaction. In addition to this hydrogenase reaction, when mutant C was grown in O_2-free conditions in the light, cells developed a H_2-nitrogenase system, characteristic of parent strain R, rubrum S_1. As a result of two hydrogenase pathways, mutant C produced 246 times more H_2 than parent strain S_1 grown similarly. A new biological source of H_2 was discovered when a species of Rhodopseudonomas, isolated in this laboratory, was grown anaerobically in the dark with CO gas. During growth, the cell metabolized CO and evolved stoichiometric amounts of H_2 and CO_2. Experiments with H-H_2O suggested that water served as an oxidant. This was the first report that a bacterial cell could grow anaerobically with CO as a sole carbon and energy source and produce H_2 by a CO-intensitive reaction other than the H_2-nitrogenase system, which was not present in the cells. Results of these studies have indicated that anoxygenic phototrophic bacterial can be used to produce large amounts of H_2.

H78 24015 LASER ISOTOPE SEPARATION

Yamashita, M., Kashiwagi, H., (Ministry of Int. Trade and Ind., Tokyo, Japan), Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku, V 188:1-2--1-29, Aug. 1976, In Japanese, J78-0042530

The recent development of technology concerning the wide tunability and narrow spectral width of a laser has made it possible to enrich and separate only one of desired groups of isotopic species efficiently through the selective excitation by the laser. It is the purpose of this report to review the work on the isotope separation by means of lasers, which has been rapidly developed since 1970, and to point out the future direction with particular attention to the application of the separation process to isotopic species related to atomic energy materials including radioisotopes. The report consists of four chapters. Chapter 1 describes the social needs for the isotope separation and some advantages of the methods for laser isotope separation over the conventional ones. Chapter 2 presents some conditions which the atomic or molecular isotopes, to be enriched or separated, and the lasers to be used are required to possess. In addition, the relation between the isotope shift and the optical spectra in atoms and molecules is discussed. In Chapter 3 is reviewed the published laser isotope separation of uranium by photoionization, hydrogen, and sulfur by molecular photodissociation, and chlorine by photochemical reaction. The principle, advantages, and problems of these methods are also discussed after the selective laser-excitation of isotopic species. All the isotopic species published as what have been enriched or separated so far by the laser methods are tabulated. In Chapter IV it is pointed out that the laser methods are suitable for enrichment or separation of isotopes of the fuel of thermal nuclear fusion such as lithium and radioisotopes such as plutonium. As the result of the review, a few new methods for laser isotope separation are proposed.

30000 III. UTILIZATION

H78 30011 HYDROGEN FUEL READY FOR BUS FLEET

Automotive Engng., V 86:78-81, N5, 1978
No abstract available.

H78 30012 HOT HYDROGEN ATOMS REACTIONS AND THE MECHANISMS OF LIQUID NORMAL ALKANES RADIOLYSIS

Avdonina, F.N., (Moscow State Univ., Moscow, USSR), Radiat. Eff., V 31:241-248, N4, 1977
J77-0049310
No abstract available.

H78 30013 HYDROGEN AS AN ENERGY CARRIER: A EUROPEAN PERSPECTIVE OF THE PROBLEM

Hagenmuller, P., (Lab. Chim. Solide, Univ. Bordeaux I, Talence, France), Adv. Chem. Ser., Solid State Chem. Energy Conversion Storage Symp., p. 1-14, series 163, 1977
No abstract available.

H78 30014 DEVELOPMENT OF A FARM HYDROGEN FUEL SYSTEM

Harris, F.W., Johnson, G.L., Turnquist, R.O., Appl, F., Clark, S., (Kansas State Univ., College of Engng., Manhattan, KS), NSF, Sept. 1973-continuing, X00-0001858

This project is concerned with the development of a system for the production, storage, and use of hydrogen as a mobile fuel on a farm. The concept involves the production of hydrogen by electrolysis at the farm site. The required electrical energy would be derived from various solar collection schemes and from conventional electric utilities during off-peak load periods.

H78 30015 PROSPECTS OF UTILIZATION OF HYDROGEN FOR CIVIL USES

Rossi, G., (Cor. Napoletana Gas, Italy), Gas, Rome, N10, p. 272-290, series 27, 1977, In Italian
No abstract available.

H78 30016 SYSTEM FOR FUEL SUPPLEMENTATION

Rounds, C.E., US Patent 4,053,683, Oct. 11, 1977, P78-0032224
Avail:Patent Office

An improved wet-plate battery for use in the electrical system of an internal combustion engine and adapted to produce hydrogen and oxygen gases for enrichment of the air/fuel mixture is disclosed. The battery includes a plurality of electrical generating cells having positive and negative plates immersed in an electrolyte. Air tubes extend through the battery case and provide communication between the space below the plates with the atmosphere. A gas discharge port is provided in the top of the case above the electrical generating cells and is connected through suitable tubing to a source of vacuum in the induction system of the engine.

H78 30017 HYDROGEN AS ENERGY STORAGE ELEMENT

Zelby, L.W., (Univ. of Oklahoma, Norman, OK), Hydrogen Econ. Miami Energy Conf. Proc., Miami Beach, FL, March 18-20, 1974, Pt. A, p. 339-343, Publ. by Plenum Press, New York, NY, 1975, R76-0014265
No abstract available.

H78 31007 ADVANCED MILITARY PROPULSION SYSTEMS

(Thermo Mechanical Systems Co., Univ. of Wisconsin, US Dept. of Defense, Army Tank-Automotive Command, Warren, MI), 1974-continuing, X00-0004714

The objective of this project is to provide the technologycal advance so that Army engines will have the capability to operate with increased economy on petroleum fuels and tolerance to nonpetroleum fuels. Combustion, exhaust emission, durability, compactness, and simplicity, new engine concepts, and engine components will be investigated. The formation of nitrogen oxides (NOX) in diesel engines is being investigated. Additionally, exploratory development of a blowdown, variable geometry turbocharger has been initiated. This task includes the building of special exhaust stacks and incorporation of a blowdown turbine with a variable diffuser compressor. In addition to continuing the above research, the feasibility of enriching standard military fuels increasing amounts of synthetic fractions such as methol, ethanol, hydrogen, and micropulverized coal dust is being studied. The operation of diesel engines at very high temperatures, transient phenomena in piston engines, and new concepts and techniques for substantial reduction in high idle fuel consumption associated with contemporary turbine practice will be investigated. A blowdown turbocharger test and test equipment for investigating NO(X) formulation in a diesel engine are to be completed.

H78 31008 STUDY OF FUEL SYSTEMS FOR LIQUID HYDROGEN FUELED SUBSONIC TRANSPORT

(NASA, Langley, Langley Stn., VA), (Lockheed-California Co., Burbank, CO), Brissenden, R.F., Sept. 29, 1976-Feb. 13, 1978, K76-12239
No abstract available.

H78 31009 HYDROGEN: PRIMARY OR SUPPLEMENTARY FUEL FOR AUTOMOTIVE ENGINES

Finegold, J.G., (Caltech, JPL, Pasadena, CA), Int. J. of Hydrogen Energy, V 3:83-104, N1, 1978
No abstract available.

H78 31010 HYDROGEN: A PORTABLE FUEL FOR MILITARY APPLICATIONS

Gregory, D.P., Pangborn, J.B., (IGT, Chicago, IL), Power Sources 26th Symp. Proc., Illinois Inst. of Tech., Chicago, IL, April 29-30 and May 1-2, 1974, p. 1-3, Publ. by PSC Publ. Commun., Red Bank, NJ, 1974, R76-0024489
No abstract available.

H78 31011 SOME CONSIDERATIONS INVOLVING HYDROGEN: RICH AUTOMOTIVE FUELS

Lampert, S., Hoffman, G.A., (Univ. of S. California, Los Angeles, CA), Greater Los Angeles Area Energy Symp. Proc., April 3, 1975, p. 165-181, Publ. by W. Periodicals Co., N. Hollywood, CA, Los Angeles Council of Engng. and Sci. Proc., V 1, 1975, R76-0057874
No abstract available.

H78 31012 SURFACE ELECTRONIC PROPERTIES AND THE SEARCH FOR NEW HYDROGEN OXIDATION CATALYSTS

Laramore, G.E., Houston, J.E., Park, R.L., (Sandia Lab., Albuquerque, NM), Hydrogen Econ. Miami Energy Conf. Proc., Miami Beach, FL, March 18-20, 1974, Pt. B, p. 889-899, Publ. by Plenum Press, New York, NY, 1975, R76-0010163
No abstract available.

H78 31013 THE TRANSITION TO LIQUID HYDROGEN AS THE PRIMARY AUTOMOTIVE FUEL

Moyer, R.E., Bell, J.E., Sutton, H.E., (Beech Aircraft Corp., Boulder Div., Boulder, CO), July 1973-indefinite, X00-0001840
A study of design options, tank optimization, fuel supply, and distribution system for hydrogen fueled automobiles. A conventional cryogenic tank has been installed in an automobile and operational experience obtained. Future work would involve optimally designed tanks and fueling systems.

H78 31014 EQUATIONS FOR APPROXIMATING THE THERMODYNAMIC DATA OF A HYDROGEN/OXYGEN STEAM GENERATOR

Schmucker, R.H., (Deutsche Forschungs und Versuchsanstalt fuer Luft und Raumfahrt, Lampoldshausen, W. Germany, Inst. fuer Chemische Antriebe und Vergahrenstechnik), In German Avail:NTIS
A hydrogen/oxygen steam generator can be considered the essential element of a future electric power station, regardless of whether it is nuclear or fossil-fuel powered. Hydrogen and oxygen are combusted in a burner similar to a rocket motor and the temperature of the hot gases is subsequently decreased to allow their use in a steam turbine. The thermodynamic values of the gases, temperature and characteristic velocity, are given in relation to various parameters and are represented by approximation equations in which corrections for stoichiometric deviations and the initial enthalpy are considered. The relations are applied to an experimental steam generator's flow efficiency showing the limits of a simple performance analysis. The influence of insufficient water evaporation and mixing can be predicted with these efficiency relations, and the accuracy of the prediction of the experimental steam generator efficiency can be estimated.

H78 31015 A STUDY ON BURNED GAS OF CONSTANT VOLUME-COMBUSTION: Part 2, NITROGEN OXIDES FORMATION WITH HYDROGEN AS FUEL

Tsukahara, M., (Muroran Inst. Tech., Muroran, Japan), Muroran Kogyo Daigaku Kenkyu Hokoku, Riko Hen, N1, p. 317-325, Series 9, 1977, In Japanese

No abstract available.

H78 31016 ENVIRONMENTAL AND ENERGY ASPECTS OF BURNING MIXTURES OF NATURAL GAS AND HYDROGEN FUEL

Varde, K.S., (Univ. of Michigan, Dearborn, MI), Energy and the Environ., Proc. of 4th Nat'l Conf., Cincinnatti, OH, Oct. 3-7, 1976, Publ. by AIChE, Dayton Sect., New Yor, NY, 1976, p. 422-433, R78-0002813

Although the technical feasibility of producing pipeline quality gas from coal has been demonstrated, the economics of coal gasification and the time factor involved in its mass production have stimulated interest in substitute for domestically produced natural gas. One of such proposals is to use a mixture of natural gas and hydrogen in various proportions. New hydrogen production techniques have aroused interest in such a scheme; it is believed that some of these production techniques can use waste heat from nuclear power plants and produce hydrogen in bulk quantities at a reasonable cost. This study looks at certain physical and combustion characteristics of such a natural gas-hydrogen mixture when used in domestic and industrial combustion equipment.

H78 32012 THERMODYNAMICS OF FUEL CELL UNIT WITH THERMAL-CATALYTICAL DISSOCIATION OF METHANOL

Baehr, H.D., Schmidt, E.F., Brennst.-Waerme-Kraft, BWK, Germany, V 29:393-400, N10, Oct. 1977, In German, B78017903

The use of normal liquid fuels instead of pure hydrogen is a condition for the economic application of fuel cells. An investigation of the various possibilities of using methanol in fuel cells shows that the direct oxidation of liquid methanol cannot lead to a technically and economically sensible solution. Therefore, an indirect fuel cell unit is investigated, whereby a hydrogen-enriched raw gas is produced by thermal-catalytical dissociation. This gas can be oxidized in fuel cells with acid electrolytes and tungsten-carbide as electrode-catalyzer, without further processing. The combustion of the residual gas containing CO, which leaves the fuel cell unit, supplies the energy required for the methanol dissociation. As calculations and tests with a pipe reactor show, a hydrogen-rich raw gas can be produced at temperatures between 350 and 400 C at a high efficiency. Thereby, total efficiencies of about 25 percent, related to the free enthalpy of the methanol used, can be obtained for the unit. This efficiency at output rates in the KW-range is considerably higher than the efficiency of conventional energy transformers.

H78 32013 NITROGEN FIXATION: NEW APPROACH WITH HABER PROCESS

Deutschman, A.J.Jr., (Nutrition and Food Science Univ. of Arizona, Tucson, AZ), July 1, 1977-Sept. 30, 1980

Use the hydrogen-nitrogen (Haber process reaction) in a fuel cell. Preliminary experiments have established that a possibility exists for recovery of the free energy in the form of electricity. Some of the requirements of the system indicate research will have to be directed towards catalyst studies, testing of various electrolyte systems that have high ohmic resistance but low ionic resistance. The incorporation of the catalyst and electrolyte will have to be fabricated into a fuel cell. All of the components will have to be compatible for successful production of a fuel cell.

H78 32014 ORBITAL PERFORMANCE OF NTS-2 NICKEL-HYDROGEN BATTERY

Dunlop, J.D., Stockel, J.F., (Electrophys. Devices Dept., COMSAT Labs., Clarksburg, MD), COMSAT Tech. Rev., V 7:639-647, N2, Fall 1977

The US Navy's navigation technology satellite (NTS-2), launched from Vandenburg Air Force Base on June 23, 1977, uses a nickel-hydrogen (Ni-H_2) battery for its energy storage subsystem. Since this is the first nickel-hydrogen battery to be flight tested, its success constitutes a significant step toward the application of this new battery technology to future communications satellites. The Ni-H_2 battery has an orbital lifetime greater than 10 years and offers the added benefit of a significant weight reduction compared with Ni-Cd batteries. This note describes the battery design and orbital performance during the first month after launching.

H78 32015 FUEL CELL ELECTROCATALYSIS: WHERE HAVE WE FAILED?

Fickett, A.P., (Electric Power Res. Inst., Palo Alto, CA), Electrochem. Soc. Spring Mtg., Papers, p. 957-959, May 8-13, 1977, Philadelphia, PA

Advocates the use of electrocatalysis research tools for investigation of the critical needs of the H_3PO_4 fuel cell.

H78 32016 DYNAMIC-FOAMED ELECTROLYTE HYDROGEN ELECTRODE

Jorne, J., (Dept. of Chem. and Metall. Engng., Wayne State Univ., Detroit, MI), J. Electrochem. Soc., V 125:94-97, N1, Jan. 1978

The hydrogen electrode was investigated in a flowing foamed electrolyte. The improved mass transfer effect reported previously by Nanis and McLarnon (1970) has been confirmed. A correlation was established between the anodic limiting current and the dynamic properties of the foam. A general agreement was found between the calculated effective mass transfer boundary layer and the measured foam's average wall thickness. These results confirm that the thin walls of the foam represent the resistive path for the diffusion of hydrogen from the bubbles to the surface of the electrode.

H78 32017 NICKEL-HYDROGEN SECONDARY BATTERIES

Klein, M., George, M., (Energy Res. Corp., Bethel, CT), Power Sources 26th Symp. Proc., Illinois Inst. of Tech., Chicago, IL, April 29-30, May 1-2, 1974, p. 18-20, Publ. by PSC Publ. Community, Red Bank, NJ, 1974, R76-0023116

No abstract available.

H78 32018 THE STATE-OF-THE-ART OF HYDROGEN-AIR PHOSPHORIC ACID ELECTROLYTE FUEL CELLS

Kunz, H.R., (Power Systems Div., United Tech. Corp., S. Windsor, CT), Electrochem. Soc. Spring Mtg. Papers, p. 985-988, May 8-13, 1977, Philadelphia, PA

The efficiency and the ultimate cost/KW that can be achieved by such power plants are dependent on the catalytic activity of platinum on both the anode and cathode. This review highlights the need for further catalyst research and development.

H78 32019 RATE LIMITING STEPS ON FUEL CELL ELECTRODES

Reti, A.R., (MIT, Cambridge Energy Conversion and Semiconductor Lab., Cambridge, MA), Contract no. Nonr-1841(78), 94 p., June 1962

The step or steps that limit fuel cell electrode performance were studied. The electrodes considered were the typical porous, gaseous diffusion type and most of the effort was directed towards acquiring a more quantitative understanding of the effect of the different variables governing electrode performance. An experimental program directed toward obtaining the necessary kinetic data for systems of interest was undertaken, and an experimental system was devised by means of which the electrochemical kinetics could be studied over a wide current density range independently of mass transfer effects on electrodes of known catalyst area. In the operating region where the effect of mass transfer became significant, it was possible quantitatively to assess its importance. For all the systems studied (O_2 and H_2O_2 electroreduction, H_2 and ethylene oxidation), for a particular catalyst-electrolyte system, the electrode performance could be described as a function of reactant concentration and current density only.

H78 32020 ASSESSMENT OF FUELS FOR POWER GENERATION BY ELECTRIC UTILITY FUEL CELLS, Final Report

Stickles, R.P., Sweeney, G.C., Mawn, P.E., Parry, J.M., (Little (Arthur D.), Inc., Cambridge, MA), N76-21741

Avail:NTIS, $9.75

The relative cost of fuel supply options for the production and distribution of fuels suitable for fuel cells was assessed, including the supply alternatives of hydrogen, synthetic gas (hydrogen/carbon monoxide), methanol, naphtha, and raw energy sources for conversion to product fuels-petroleum, natural gas, coal, and municipal solid waste. Comparative economics of fuel cell power systems from raw of primary fuel to electricity were developed based on forecasted energy prices for 1978-1990. The integration of on-site fuel conversion with the fuel cell power sections was considered to utilize waste heat and water from the stack. The integration of coal gasifiers with fuel cell plants was also investigated.

H78 32021 RECENT ADVANCES IN ELECTROCATALYSIS AND THEIR IMPLICATIONS FOR FUEL CELLS

Vielstich, W., (Inst. fur Phys. Chem., Univ. of Bonn, Bonn, Germany), Electrochem. Soc. Spring Mtg. Papers, p. 951, May 8-13, 1977, Philadelphia, PA

Thirty different alcohols and their oxidation products have been the subject of a systematic investigation at platinum electrodes in H_2SO_4 solution in order to evaluate the electrochemical activity as a function of the structure of these compounds. The result is that only the number of hydrogen atoms at the α-carbon atom determines the electrochemical behavior. Other structural characteristics as chain length, double bond or ring formation are of minor importance.

H78 33014 CHARACTERISTICS OF HYDROGENATION WORKS

(I.G. Farbenindustrie, Ludwigshafen, Germany), (Texas A and M Univ., College Stn., TX), 1942, R78-0006847

Varied information is included on the operations of the following plants: Leuna, Scholven, Boehlen, Magdeburg, Welheim, Gelsenberg, Zeitz, Luetzkendorf, Poelitz, Bruex, Wesseling, and Blechhammer. The information given includes: production of aviation gasoline, diesel oil, and fuel gas; production methods with numbers of stalls, raw materials, and pressures; difficulties encountered; hydrogen production coupled with ammonia and methanol synthesis; power generation; production of by-products, such as alkylates, sulfur, and nitrogen; power and fuel gas requirements; and production capacities. Some of the production capacities in 1940 were: (1)Leuna, 600,000 tons/yr automobile gasoline; (2)Scholven, 210,000 tons/yr aviation fuel and 25,000 tons/yr fuel gas; (3)Boehlen and Magdeburg, 120,000 tons/yr automobile gasoline, 120,000 tons/yr diesel oil, and 180,000 tons/yr aviation gasoline; (4)Welheim, 36,000 tons/yr aviation gasoline and84,000 tons/yr fuel oil; (5)Gelsenberg, 340,000 tons/yr aviation gasoline and 70,000 tons/yr fuel gas; (6)Zeitz, 100,000 tons/yr motor gasoline, 170,000 tons/yr diesel oil, 25,000 tons/yr paraffin, and 15,000 tons/yr lubricating oil; (7)Luetzkendorf, 10,000 tons/yr diesel oil; (8)Poelitz, 200,000 tons/yr aviation gasoline and 150,000 tons/yr high-test gasoline; (9)Burex, expected production of 300,000 tons/yr automobile gasoline and 300,000 tons/yr aviation gasoline; (10)Wesseling, 45,000 tons/yr motor gasoline and 60,000 tons/yr diesel gasoline; and (11)Blechhammer, 240,000 tons/yr aviation gasoline, 260,000 tons/yr fuel oil, and 60,000 tons/yr fuel gas.

H78 33015 NUCLEAR ENERGY AND THE STEEL INDUSTRY

Barnes, R.S., (British Steel Corp., London, England), Steklo Keram., V 205:822-832, N8, Aug. 1977, J78-0032010

Fossil fuels represent a large part of the cost of iron and steel making and their increasing cost has stimulated investigation of methods to reduce the use of fossil fuels in the steel industry. Various iron and steel making routes have been studied by the European Nuclear Steelmaking Club (ENSEC) and others to determine to what extent they could use energy derived from a nuclear reactor to reduce the amount of fossil fuel consumed. The most promising concept is a high-temperature gas-cooled nuclear reactor heating helium to a temperature sufficient to steam reform hydrocarbons into reducing gases for the direct reduction of iron ores. It is proposed that the reactor/reformer complex should be separate from the direct-reduction plant/steelworks and should provide reducing gas by pipeline, not only to a number of steel works but to other industrial users. The composition of suitable reducing gases and the methods of producing them from various feedstocks are discussed. Highly industrialized countries with large steel and chemical industries have shown greater interest in the concept, but those countries with large iron-ore reserves and growing direct capacity should consider the future value of the high-temperature gas-cooled reactor as a means of extending the life of their gas reserves.

H78 33016 AN ELECTROCHEMICALLY REGENERATIVE HYDROGEN-CHLORINE ENERGY STORAGE SYSTEM FOR ELECTRIC UTILITIES

Gileadi, E., Srinivasan, S., Salzano, F.J., Braun, C., Beaufrere, A., Gottesfeld, S., Nuttal, L.J., Laconti, A.B., (Dept. of Appl. Sci., Brookhaven Nat'l Lab., Upton, NY), J. Power Sources, Switzerland, V 2:191-200, N2, Dec., 1977

Electrolysis of HCl and storage of hydrogen and chlorine is proposed as a means of electrical energy storage. An economic evaluation is presented which shows that the system has a clear advantage over the hydrogen-air storage system and is comparable in cost to gas turbines. The system is flexible, allowing both energy storage and hydrogen production for industrial purposes, and lends itself easily to scale-up. Assuming that the rand goals of this new system are met, it will compete successfully with all other electric energy storage devices presently considered.

H78 33017 DESIGN CONSIDERATIONS OF HYDROGEN-POWER REACTOR SYSTEMS

Viswanathan, M.N., (Hunter Distr. Water Board, Newcastle West., Australia), Inst. of Engng, Annual Engng. Conf., Townsville, Australia, May 10-14, 1976, Publ. by Inst. of Engng., Sydney, Australia, Pap. no. 424/2, p. 58-62, R77-005190

No abstract available.

H78 34015 SYNTHESIS OF SILANE AND SILICON IN A NON-EQUILIBRIUM PLASMA JET

Calcote, H.F., Felder, W., (Aerochem. Res. Labs., Inc., Princeton, NJ), Quarterly Rept. March 21-June 20, 1977, Contract no. NAS7-100, JPL-954560
Avail:NTIS

The feasibility of high volume, low-cost production of high purity silane or solar grade silicon using a non-equilibrium hydrogen atom plasma jet was studied through reactions of hydrogen atoms in the plasma jet with chlorosilanes. Products of the $H/SiCl_4$ reaction were collected and quantitatively analyzed using a fractionation/distillation-mass spectrometric technique. Conversion of $SiCl_4$ gave smaller product yield and different product distribution than did technical grade. Real time, in situ mass spectrometric sampling of the $H/H_2/SiCl_4$ reaction zone gases was initiated. Quantitative results have not been obtained due to the complexity of the chlorosilane mass spectra, and consequent resolution and sensitivity difficulties with the mass spectrometer. Improvements in the instrumentation needed for these measurements are discussed.

H78 34016 HYDROGEN FUELED GAS DYNAMIC LASER

Cavalleri, R.J., (Atlas Res. Corp., Alexandria, VA), Hydrogen Econ. Miami Energy Conf. Proc., Miami Beach, FL, March 18-20, 1974, Pt. B, p. 677-684, Publ. by Plenum Press, New York, NY, 1975, R76-0010524

H78 34017 REACTION OF COAL IN ARGON AND ARGON-HYDROGEN PLASMAS

Kawa, W., Graves, R.D., Hiteshue, R.W., (Bureau of Mines, Washington, D.C.), (Univ. of Tennessee Library, Knoxville, TN), 1966, R78-0013372

Coals of various rank were reacted by the Bureau of Mines in plasma jets generated from argon and argon-hydrogen mixtures containing up to 33 volume percent hydrogen. Average plasma temperatures ranged from about 3400 to 12,000 C. Products were a solid residue and a gas containing hydrogen, methane, acetylene, diacetylene, and oxides of carbon. The highest yield of acetylene obtained with argon plasmas was 15 percent by weight of moisture and ash-free coal. The data indicated that acetylene yields of 40 percent can be obtained from the reaction of coal in argon-hydrogen plasmas, although results from these experiments could not be correlated with operating variables because of low recoveries. The plasmas contained sufficient energy to heat the coal to temperatures as high as 9000 or 10,000 C, but complete devolatilization did not occur in any experiment.

H78 34018 MECHANISM OF THE SYNTHESIS OF HYDROCARBONS FROM CARBON MONOXIDE AND HYDROGEN

Levinson, P., (Bureau of Mines, Washington, D.C.), Rept. from Univ. of Tennessee Library Knoxville, TN, 1958, R78-0025426

Methane separation and hydrogen recycle offers an attractive approach for high-BTU gas production, provided there are no excessive counterbalancing costs. If operated as a fixed-bed process, it presents an adaption of the Lurgi pressure gasifier modified for hydrogen recycle to the upper portions of the fuel bed. If operated as a fluidized process it does not differ in principle from fluidized-hydrogenation, residual-fuel gasification schemes proposed or under investigation. A single-vessel fluid bed, where both oxygen and hydrogen are introduced, is disadvantageous by virtue of rapid fuel mixing, resulting in some volatile matter being burned by oxygen. Because the volatile portion of the fuel is the most readily hydrogenated component, an effective fluid-bed system would require a separate reactor to complete the volatile-matter hydrogenating reactions and a second vessel, immediately below the first, to gasify residual carbon with oxygen and steam. The hot gases from the second vessel would be admitted to the hydrogenation reactor. An alternative to methane separation in this proposed process is catalytic methanation of carbon monoxide and hydrogen in the raw gas, yielding gases of high methane content but requiring an external source of hydrogen.

H78 34019 LASER FUSION

Stickley, C.M., (US Dept. of Energy, Washington, D.C.), Phys. Today, V 31:50-58, N5, May 1978

Will a series of nuclear explosions in miniature pellets of hydrogen, ignited to fusion by laser-light beams, become a long-term method for supplying the world's energy needs?

H78 34020 BREECH CLOSURE MECHANISM

Teng, R.K., (Dept. of Air Force, Washington, D.C.), PAT-APPL-865 467, Filed Dec. 29, 1977 10 p
Avail:NTIS

The patent application relates to a mechanism for releasably holding and pre-heating a model, prior to launch of the model by and from a gun. The model is initially held in a collar of the mechanism in the breech of the gun, and is pre-heated by an induction coil and an r-f current. The coil is then removed, and the model and the collar are propelled forward through the breech by pressurized hydrogen gas, with the breech being closed and with the heated model being inserted into the launch tube (i.e., the "barrel") of the gun. The gun is then fired, and the heated model is launched, without any significant cooling of the model. Some advantages of this mechanism are a quick "heat-and-fire" cycle, and the simplicity in structure and in operation of the mechanism.

H78 34021 PLASMA STUDIES ON A DUOPIGATRON ION SOURCE

Tsai, C.C., Stirling, W.L., Ryan, P.M., (ORNL, Oak Ridge, TN), Rev. Sci. Instrum., V 48: 651-655, N6, June 1977, J77-0092196
No abstract available.

40000 IV. TRANSMISSION, DISTRIBUTION, AND STORAGE

H78 40013 NOVEL HYDROGEN COMPRESSOR

Boser, O., Lehrfeld, D., (Philips Lab., Briarcliff Manor, NY), Power Sources 26th Symp. Proc., Illinois Inst. of Tech., Chicago, IL, April 29-30 and May 1-2, 1974, p. 3-6, Publ. by PSC Publ. Community, Red Bank, NJ, R76-0024490

No abstract available.

H78 40014 PALLADIUM-HYDROGEN SYSTEM

Brodowsky, H., (ORNL, Oak Ridge, TN), Z. Phys. Chem., Frankfurt, V 44:129-142, N77-19230
Avail:NTIS

The solubility of hydrogen in palladium is of interest because of the dissociation of the dissolved hydrogen atoms to protons and electrons. The difference from an ideal misture behavior results on the one hand from filing up of the electron shell of the metal and on the other, local expansion and loading of the lattice due to the thermal motion of protons. The loading leads to an association tendency of the protons, part of which is calculated from the chemical potential of the dissolved hydrogen by the quasi-chemical method. The solubility of light and heavy hydrogen can be described in a manner completely analogous, yet the association energy of the deuterons, because of their smaller oscillation amplitude, is somewhat smaller than that of the protons. The difference in the association energies can be derived independently from an expression for the separation factor.

H78 40015 ECONOMIC COMPARISON OF DIFFERENT FORMS OF ENERGY TRANSPORT

Hauk, V., Energy Engng. Conv. of Lines of Dev. in Energy Engng., Prepr., Duesseldorf, Germany, May 5-7, 1975, p. 141-151, Publ. by VDI-Verlag, Duesseldorf, Germany, 1975

No abstract available.

H78 40016 LONG-DISTANCE TRANSPORT OF OIL, GAS, AND COAL BY PIPELINES UNDER THE ASPECT OF SAFE OPERATION

Kuhlmann, A., (VDI, Cologne, Germany), Energy Engng. Conv. of Lines of Dev. in Energy Engng., Prepr., Duesseldorf, Germany, May 5-7, 1975, p. 167-177, Publ. by VDI-Verlag, Duesseldorf, Germany, 1975, R76-0017077

No abstract available.

H78 40017 ATOMIC HYDROGEN STORAGE METHOD AND APPARATUS

Woolam, J.A., (NASA, Lewis, Cleveland, OH), PAT-APPL-837 794, Filed Sept. 29, 1977, 10 p., NASA-CASE-LEW-12081-2
Avail:NTIS

Atomic hydrogen, for use as a fuel or as an explosive, is stored in the presence of a strong magnetic field in exfoliated layered compounds such as molybdenum disulfide or an elemental layer material such as graphite. The compound is maintained at liquid helium temperatures and the atomic hydrogen is collected on the surfaces of the layered compound which are exposed during delamination (exfoliation). The strong magnetic field and the low temperature combine to prevent the atoms of hydrogen from recombining to form molecules.

H78 42001 CRYOGENIC SYSTEMS

Chato, J.C., (Univ. of Illinois, Urbana-Champaign, Urbana, IL), 1974-continuing

Various cryogenic problems are investigated. In particular, the behavior of large-scale, porous, gas-filled insulations are studied with special emphasis on the effects of natural circulation. These types of insulations are used for storing and shipping cryogenic fluids such as liquefied natural gas. Other studies include the liquefaction and storage of various cryogenic fuels such as hydrogen and liquefied natural gas.

H78 42002 CRYOCONDENSATION PUMPING OF TRITIUM AND ITS MIXTURES WITH D_2 and H_2

Chou, T.S., Halama, H.J., (BNL, Upton, NY, Dept. of Energy), Symp. on Fusion Res. Projects, Knoxville, TN, Oct. 25, 1977, Contract no. EY-76-C-02-0016, 3 p.
Avail:NTIS

An apparatus used to obtain data on the cryocondensation pumping deuterium, hydrogen, and helium mixtures was modified and moved to a sealed enclosure in the Hot Lab to measure pumping characteristics of tritium on smooth surfaces at 4.2 K. Two cylinders containing approximately 1500 curie of tritium each were used in two experimental runs. Due to a large 3He content palladium thimbles had to be used for purification. At the end of each experiment, T_2 was stored in Ti films, evaporated from Ti filament. The pumping speed of T_2 was found to be insensitive to the flux and the thickness of the condensed layers behaving much like H_2 and D_2. The limit on the flux, surface coverage and the cryogen consumption was always imposed by the low 3He trapping efficiency of hydrogen isotopes. T_2 vapor pressure at 4.2 K was below our detection sensitivity of 4 x 10^{-11} Torr. The effects of 18 keV electrons on liquid helium consumption as well as on desorption from composite frozen layer was found to be negligible. THO formed on the walls of our experimental setup by reaction of T_2 with H_2O present on the surface. This suggests the necessity of a bakeout for equipment which will be used in fusion reactor systems. Finally, total heat contents and thermodynamical equilibrium constants obtained in these experiments were compared with calculations.

H78 42003 INSTRUMENTATION FOR CRYOGENIC HYDROGEN FUEL

Flynn, T.M., (NBS, Inst. for Basic Stand., Boulder, CO), NBS Spec. Publ., N419, May 1975, Pap. 5, 31 p. J76-0031694
No abstract available.

H78 42004 LIQUEFACTION: EFFECTS OF COMPONENT EFFICIENCIES

Voth, R.O., Daney, D.E., (NBS, Boulder, CO), Intersoc. Energy Conv. Engng. 10th Conf. Rec., Univ. of Delaware, Newark, DE, Aug. 18-22, 1975, Pap. 759198, p. 1356-1362, Publ. by IEEE, Cat. no. 75CHO 983-7 TAB, New York, NY, 1975,R76-0010136
No abstract available.

H78 43012 STUDY OF HYDROGEN SLUSH-HYDROGEN GEL UTILIZATION

Keller, C.W.
The study of hydrogen slush-hydrogen gel utilization is presented in a two-volume publication. The first volume contains the physical and thermal property data for hydrogen used in the study. In the second volume, details of the technical effort are presented including paramatric analysis of effects on vehicle systems.

H78 43013 MOLECULAR AND METALLIC HYDROGEN

Ross, M., Shishkevish, C., (Rand, Santa Monica, CA), 1977
The authors deal with metallic hydrogen, i.e., a metallic phase of hydrogen that, according to theory, should exist at extremely high pressures (p>1M). The possibility exists that metallic hydrogen may be an elevated temperature superconductor, a very efficient rocket fuel, or a powerful explosive. Theoretical calculations are reported of the equations of state of both molecular and metallic hydrogen required for calculations of the transition pressure into the metallic phase. The range of pressures at which the metallic hydrogen transition should occur is estimated. Metastability (i.e., stability of metallic hydrogen at low pressures) is discussed. The experimental data used in calculating the molecular equation of state of hydrogen are summarized and the experimental high-pressure research pertinent to the molecular-to-metallic hydrogen transition is reviewed.

H78 43014 METHOD OF PREPARING SLUSH OF LOW-BOILING GASES

Schraewer, R., Bardenheier, J., Koch, J., German Patent no. 2,423,610/A, Nov. 27, 1975, In German, P78-0030268
A mixture of liquid and solid ice low-boiling gases (e.g., nitrogen or hydrogen) is especially suited for certain types of applications. The precondition for the utilization of this method is the existence of monocrystals with a size between 1 and 3 mm. The invention advises to achieve this in the following way: the low-cooled gas is expanded alternately in a nozzle down to a pressure below the triple point (gas-ice area) and up to a pressure above the triple point (gas-liquid area). The expansion is carried out under isenthalpic conditions. The periodical changing of the expansion pressure is to be done at intervals of five to ten seconds. Further claims consider the arrangement of the nozzle and the application of the slush.

H78 44001 CLUSTER CALCULATIONS OF THE ELECTRONIC STRUCTURE IN INTERSTITIAL HYDROGEN IN TITANIUM, NICKEL, AND PALLADIUM

Adachi, H., Imoto, S., Tanabe, T., Tsukada, M., (Dept. Nuclear Engng., Osaka Univ., Suita, Japan), J. Phys. Soc. Japan, N3, p. 1039-1040, series 44, 1978
No abstract available.

H78 44002 STRESS INDUCED REORIENTATION OF VANADIUM HYDRIDE

Beardsley, M.B., (Ames Lab., Ames, IA, Dept. of Energy), Contract no. W-7405-ENG-82, 48 p., Oct. 1977
Avail:NTIS

The critical stress for the reorientation of vanadium hydride was determined for the temperature range 180 to 280 K using flat tensile samples containing 50 to 500 ppM hydrogen by weight. The critical stress was observed to vary from a half to a third of the macroscopic yield stress of pure vanadium over the temperature range. The vanadium hydride could not be stress induced to precipitate above its stress-free precipitation temperature by uniaxial tensile stresses or triaxial tensile stresses induced by a notch.

H78 44003 ENERGY RELATED RESEARCH ON METAL HYDRIDES AT MOUND

Bowman, R.C., (Mound Lab., Miamisburg, OH, Dept. of Energy), Contract no. EY-76-C-04-0053, 28 p., 1977, Physics Dept. Seminar, Dayton, OH, Nov. 14, 1977
Avail:NTIS

After a brief review of the hydrogen fuel cycle where selected metal hydrides have important energy storage applications, a general description of the hydride research activities supported at Mound by the US Dept. of Energy will be presented. Current investigations of the vanadium-hydrogen system will illustrate various solid-state problems involving diffusion, phase diagrams, and isotope effects.

H78 44004 INVESTIGATION OF VANADIUM HYDRIDES BY THE NMR METHOD

Eristavi, B.G., Shevakin, A.F., (Acad. of Sci, Moscow, USSR), Izv. Akad. Nauk SSSR Met., N6, p. 200-204, Nov.-Dec. 1977, Trans. in Russian Metall.

The authors conduct NMR measurements in the temperature interval from 130 to 450 K on three vanadium hydrides, $VH_{0.84}$, $VH_{1.21}$, and $VH_{1.75}$, all of which can exist as both a β and a γ phase. Analysis of the NMR spectra shows that both the β and γ hydrides undergo a phase transition in the temperature interval 190 to 230 K. The activation energy for diffusion of hydrogen in $VH_{0.84}$ is measured as 3.3 Kcals/mole in the β phase and as 9.7 Kcals/mole in the γ phase.

H78 44005 TRANSITION-METAL HYDRIDES: ELECTRONIC STRUCTURE AND THE HEATS OF FORMATION

Gelatt, C.D.Jr, Ehrenreich, H., Weiss, J.A., (Phys. Dept., Harvard Univ., Cambridge, MA), Phys. Rev. B., N4, p. 1940-1957, series 17, 1978
No abstract available.

H78 44006 DETAILED ANALYSIS OF THE HYDRIDING CHARACTERISTICS OF $LANI_5$

Lundin, C.E., Lynch, F.E., (Univ. of Denver, Denver, CO), Intersoc. Energy Conv. Engng. 10th Conf. Rec., Univ. of Delaware, Newark, DE, Aug. 18-22, 1975, Pap. 759201, P. 1380-1385 Publ. by IEEE, Cat. no. 75CHO 983-7 TAB, New York, NY, 1975, R76-0010131
No abstract available.

H78 44007 STUDIES OF HYDRIDE FORMATION IN TITANIUM ZIRCONIUM MANGANESE (Ti_1-xZrxMn_2)

Oesterreicher, H., Bittner, H., (Dept. Chem., Univ. of California, La Jolla, CA), Mater. Res. Bulletin, N1, p. 83-88, series 13, 1978
No abstract available.

H78 44008 THE EFFECT OF P, D, AND F GAUSSIAN POLARIZATION FUNCTIONS ON THE COMPUTED ONE-ELECTRON PROPERTIES OF AHn OXYGEN AND SULFUR HYDRIDES

Poirier, R., Kari, R., (Dept. Chem., Laurentian Univ., Sudbury, Ontario), Can. J. Chem., N4, p. 543-551, series 56, 1978
No abstract available.

H78 44009 DYNAMICS OF ENERGY AND MASS TRANSFER WITH REACTION IN HYDRIDE STORAGE SYSTEMS

Powers, G.J., Cummings, D.L., (MIT, Cambridge, MA), Hydrogen Econ. Miami Energy Conf. Proc., Miami Beach, FL, March 18-20, 1974, Pt. B, p. 803-817, Publ. by Plenum Press, New York, NY, 1975, R76-0010177

No abstract available.

H78 44010 HEAT STORAGE IN THE MAGNESIUM-HYDROGEN SYSTEM

Rummel, W., (Siemens Ag, Erlangen, Germany), Siemens Forsch and Entwicklungsber., Germany, V 7:44-50, N1, 1978, In German

The possibility of storing heat in the form of latent heat (reaction enthalpy) and of releasing this heat by reaction of two components by the decomposition of metal hydrides is demonstrated by way of example of magnesium and hydrogen. The storage cycle, which in the example discussed takes place between 600 K and a maximum of 800 K, is described by an energy-flow diagram. The estimated efficiency of heat recovery under the most unfavorable conditions is about 60 percent. If the sensible heat of storage can be utilized in addition to the latent heat, efficiencies over 85 percent can be obtained. The possibilities of further improving the efficiency and of a better utilization of the energy are dealt with.

H78 44011 LOW TEMPERATURE HEAT CAPACITY OF LUTETIUM AND LUTETIUM HYDROGEN ALLOYS

Thome, D.K., (Ames Lab., Ames, IA, Dept. of Energy), Contract no. W-7405-ENG-82, 70 p., Oct. 1977

Avail:NTIS

The heat capacity of high purity electrotransport refined lutetium was measured between 1 and 20 K. Results for θ_D were in excellent agreement with θ values determined from elastic constant measurements. The heat capacity of a series of lutetium-hydrogen solid solution alloys was determined and results showed an increase in γ from 8.2 to about 11.3 mJ/g-atom-K^2 for hydrogen content increasing from zero to about one atomic percent. Above one percent hydrogen γ decreased with increasing hydrogen contents. The C/T data showed an increase with temperature decreasing below about 2.5 K for samples with 0.1 to 1.5 atomic percent hydrogen. This accounts for a large amount of scatter in θ_D versus hydrogen content in this range. The heat capacity of a bulk sample of lutetium dihydride was measured between 1 and 20 K and showed a large increase in θ_D and a large decrease in γ compared to pure lutetium.

H78 44012 KINETICS OF REACTION OF ZIRCONIUM ALLOY WITH HYDROGEN

Une, K., (Toshiba Res. and Dev. Center, Tokyo Shibaura Electric Co. Ltd., Komukai, Kawasaki, Japan), J. Less-Common Met., Switzerland, V 57:93-101, N1, Jan. 1978

The kinetics of hydriding of zircaloy-2 tube were studied at hydrogen partial pressures from 0.2 to 1 atm. in the temperature range of 300-500 C, by means of thermogravimetric techniques. As a result of the analysis of the reaction curves, it has been suggested that the rate-controlling step is a phase boundary controlled reaction, the activation energy of which is 16.3 Kcal Mol^{-1}. The T_{in}=ΔL relationship was studied on the oxidized specimens, where T_{in} is the initiation time of hydride precipitation and Δl is the oxide film thickness. This relationship suggests that hydrogen diffusion ZRO_{2-x} on a zircaloy surface is a rate-controlling step until the film is broken. Marked hydriding in H_2-H_2O gas mixtures occurred when the ratio of hydrogen to water vapor pressure reached more than about $10^5$and 10^2 at 300 and 400 C, respectively.

50000 V. SAFETY

H78 50001 IGNITION DANGERS FROM ELECTROSTATICALLY CHARGED CARBON DIOXIDE CLOUDS

Heidelberg, E., Nabert, K., Schoen, G., (British Library Lending Div., Boston Spa, England), Transl. to English from Arbeitsschutz, W. Germany, V 12:242-245, 1958, N76-71460
Avail:NTIS
No abstract available.

H78 50002 SAFETY CHARACTERISTICS OF FETI HYDRIDE

Lundin, C.E., Lynch, F.E., (Univ. of Denver, Denver, CO), Intersoc. Energy Conv. Engng. 10th Conf. Rec., Univ. of Delaware, Newark, DE, Aug. 18-20, 1975, Pap. no 759202, p. 1386-1890, Publ. by IEEE, New York, NY, 1975, R76-0010132
Avail:NTIS
No abstract available.

H78 50003 SAFETY

Ordin, P.M., Proc. Conf. on Sel. Tech. for the Gas Industry, Cleveland, OH, March 19-20, 1975, p. 109-128, NASA Spec. Publ. no. 5103 1975, J76-0032832
No abstract available.

H78 50004 SAFETY ASPECTS OF HYDROGEN TECHNOLOGY

Pennings, P., (Technischer Ueberwachungs-verein Rheinland E.V., Koeln, Germany, F.R.), Gas Wasserfach, Gas-Erdgas, V 118:230-235, N6, 1977, In Germany, J78-0030265
Avail:NTIS
Starting from the physical properties of the energy source hydrogen by means of which the essential risks of this gas can be easily deduced, the main characteristics of hydrogen handling are presented with regard to safety aspects and other relevant criteria. Hydrogen technology is dealt with under this aspect, divided in production, storage, and distribution, as well as the utilization of hydrogen.

60000 VI. MATERIALS

H78 60001 IRON SULFIDE COATINGS TO REDUCE HYDROGEN DAMAGE IN H_2S ENVIRONMENTS

Doutovich, D.P., Hay, M.G., (Ontario Hydro Res. Labs., Toronto, Canada), Can. Chem. Process., V 61:19-20, N6, June 1977, C78-0044879

At Ontario Hydro's Bruce heavy water plant, hydrogen damage in the form of blistering, delaminations, and surface fissures has been observed in carbon-steel absorber towers and run-down tanks. Damage occurred where preexisting defects were exposed to hydrogen sulfide gas, not where the steel was exposed to liquid. The remedy was found to be preconditioning the steel by treatment with a solution of hydrogen sulfide in water to give a thin impermeable coating of iron sulfide.

H78 60002 EFFECT OF PURITY, PRESTRAIN, AND COOLING RATE ON HYDROGEN STRENGTHENING IN NIOBIUM SINGLE CRYSTALS

Fournier, R., Gibala, R., (Case Western Reserve Univ., Cleveland, OH, Dept. of Metall. and Materials Sci., Dept. of Energy), Contract no. EY-76-S-02-1676, Int. Congress on Hydrogen in Metals, Paris, France, June 1977, 8 p.,
Avail:NTIS

Hydrogen strengthening of niobium at approximately 77 K depends on purity, prestrain at 295 K, and cooling rate from 295 K. Increasing purity, prestrain, and decreasing cooling rate reduce hydrogen strengthening. High purity alloys exhibit hydride softening, a decrease in flow stress with increasing hydrogen content.

H78 60003 SURVEY OF MATERIALS FOR HYDROGEN SERVICE

Hust, J.G., (NBS, Inst for Basic Stand., Boulder, CO), NBS Spec. Publ. no. 419, Pap. 4, 55 p., May 1975, J76-0031690

No abstract available.

H78 60004 BRITTLE FAILURE OF WATERWALL TUBES IN NATURAL CIRCULATION BOILERS

Kot, A.A., Pronina, G.G., Lesova, V.D., (All-Union Heat Engng. Inst., USSR), Teploenergetika, USSR, V 23:63-66, N11, Nov. 1976, Engl. Transl. in Thermal Engng.

No abstract available.

H78 60005 IMPLICATIONS OF FUEL PERFORMANCE OF PLANT MANEUVERING

Montgomery, M.H., Wilson, H.W., (Babcock and Wilcox Co., Lynchburg, VA), Trans. Am. Nucl. Soc., V 26, suppl. 1, Conf. on Reactor Operating Experience, Aug. 7-10, 1977, Chattanooga, TN

One mechanism of concern for pellet-cladding interaction (PCI) is a mechanical failure caused by straining the cladding beyond its strain capability. Failures of this type require a cladding with greatly degraded mechanical properties. Degraded mechanical properties can result from partial hydriding of the cladding, manufacturing defects, and irradiation damage. Improved manufacturing techniques and control on the internal sources of hydrogen and the cladding properties have generally eliminated these as major problems Recent measurements on irradiation damage under PWR conditions show that this effect is not as severe as once was thought.

H78 60006 HYDROGEN EMBRITTLEMENT OF THERMOMECHANICALLY TREATED 18Ni MARAGING STEEL

Munford, J.W., Rack, H.J., Kass, W.J., (Sandia Labs., Albuquerque, NM, Dept. of Energy), Contract no EY-76-C-04-0789, Conf. on Environ. Degradation of Engng. Materials, Blacksburg, VA, Oct. 10, 1977, 11 p.
Avail:NTIS

The influence of thermomechanical treatments on susceptibility to cracking in 100 percent relative humidity air and low pressure (93.3 KPa) gaseous hydrogen has been investigated for 18 Ni (350 ksi) Maraging steel. Two thermomechanical treatments were studied, ausforming and marforming and compared with the standard solution-treated and aged material. Although little difference exists for the strength and toughness values between these treatments, a two to five-fold increase in the stress intensity threshold for cracking was found for both the ausformed and marformed material. A dramatic difference in cracking kinetics was also apparent as shown by the failure times at comparable stress intensities. Fractographic analysis showed that the primary fracture mode was 100 percent intergranular for the solution treated and aged samples while the ausform and marform failures were predominately quasi-cleavage or intergranular depending on orientation. Finally, permeation and diffusion measurements were conducted on the above materials and these results are correlated with environmental cracking behavior.

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ICATION, FUEL-GAS, CATALYSIS,	FUEL-OILS# /IQUEFACTION, GASIF	023010
PELLET-CLADDING-INTERACTION,	FUEL-PERFORMANCE# /OWER-PLANT,	060005
INES, COMPRESSOR, PRODUCTION,	FUEL-PROPERTIES, RECIPROCATING	010058
YDROGEN, METALLIC, MOLECULAR,	FUEL-ROCKET, EXPLOSIVES, HIGH-	043013
TIONS, NATURAL-GAS-LIQUIFIED,	FUEL-STORAGE# /OGENICS, INSULA	042001
ELL, CATALYSTS, ELECTROLYTES,	FUEL, CATALYST-STUDIES# /UEL-C	032013
UEL-OILS, CATALYTIC-CRACKING,	FUEL, CELLS# /-LIQUEFACTION, F	010059
OGENICS# HYDROGEN-ATOMIC,	FUEL, EXPLOSIVES, STORAGE, CRY	040017
SIS, PHOSPHORIC-ACID#	FUEL, FUEL-CELL, ELECTROCATALY	032015
OMBUSTION, MIXTURES, NATURAL,	FUEL# /ATURAL-GAS, HYDROGEN, C	031016
SYNFUEL, FUEL-OIL-ADDITIVES,	FUELS-FROM-WASTE# /-CHEMISTRY,	010041

DDITIVES, AMMONIA-FEEDSTOCKS,	FUELS-FROM-WASTES, THERMOCHEMI	010041
ICS, SOLAR-COLLECTORS, ELECTR/	FUELS, AGRICULTURE, ELECTROLYS	030014
	FUELS, AUTOMOTIVE-ENGINES#	031009
AR-ENERGY, ENERGY-COMPANY#	FUELS, ENERGY-RESOURCES, NUCLE	010044
COST, AVAILABILITY,	FUELS, LIQUEFACTION#	010060
N, PHYSIOCHEMICAL-PROPERTIES,	FUELS, ORGANIC-COMPOUNDS, MANU	023012
URFACE-ELECTRONIC-PROPERTIES,	FUELS, OXIDATION, CATALYSTS# /	031012
TION-DATA# HYDROGENATION,	FUELS, PLANT-OPERATION, PRODUC	033014
RIC-UTILITY, FUEL-CELLS, FUE/	FUELS, POWER-GENERATION, ELECT	032020
DUCTION, HYDROGEN#	FUELS, STEAM-IRON-PROCESS, PRO	024004
ELECTROLYSIS,	FUELS, WATER, MANUFACTURE#	021026
ELECTROLYSIS,	FUELS, WATER, PRODUCTION#	021025
ECTROLYSIS, ENERGY-RESOURCES,	FUELS# EL	021023
ERGY-RESOURCES, ELECTROLYSIS,	FUELS# EN	010046
EL-CELLS, ELECTRIC-BATTERIES,	FUELS# FU	010043
ENERGY-ROUTES, STEEL-MAKING,	FUELS#	010042
APPLICATIONS-FUTURE,	FUELS#	010049
SOLAR-ENERGY, OCEANOGRAPHY,	FUELS#	024006
RAL-GAS-LIQUEFIED, AEROSPACE,	FUELS# SAFETY, NATU	050003
GENERATION, ENERGY-RESOURCES,	FUELS# ELECTRIC-POWER-	010050
METHANOL, ENRICHING, METHOL,	FUELS# /, COMBUSTION, ETHANOL,	031007
RS, HYDROGEN-PELLETS# LASER,	FUSION, YIELDS, NEODYMIUM-LASE	034019
SAFETY, ELECTROSTATIC-CHARGE,	GAS-EXPLOSIONS, DETONABLE-GAS-	050001
IS, STORAGE, TRANSPORT, PROD/	GAS-INDUSTRY, WATER-ELECTROLYS	010048
-STORAGE, GAS, METAL-HYDRIDE,	GAS-TURBINE# /ODUCTION, ENERGY	021022
PROCATING-ENGINE-PERFORMANCE,	GAS-TURBINES, RECIPROCATING-EN	010058
C-PRODUCTION, ENERGY-STORAGE,	GAS, METAL-HYDRIDE, GAS-TURBIN	021022
SLUSH-PREPARATION,	GASES-LOW-BOILING, CRYOGENICS#	043014
PIPELINES, COAL-GASIFICATION,	GASES# METALS-AND-ALLOYS,	010052
OUR, COAL, COAL-GASIFICATION,	GASIFICATION, CONVERSION, AMMO	023009
SIS, FUE/ COAL, LIQUEFACTION,	GASIFICATION, FUEL-GAS, CATALY	023010
, METHANE, METHANOL, ETHANOL,	GASIFICATION# /S, FERMENTATION	020012
S, OXYGEN, SULFUR, ELECTRONI/	GAUSSIAN-POLARIZATION, HYDRIDE	044008
PATENT, PRESSURIZED-HYDROGEN,	GUN-LAUNCHERS# /H-MECHANISMS,	034020
LYSTS, EL/ NITROGEN-FIXATION,	HABER-PROCESS, FUEL-CELL, CATA	032013
LS, HYDRIDATION, FLOW-STRESS,	HARDENING, HEAT-TREATMENT# /TA	060002
STRESS-INDUCED-REORIENTATION,	HARDENING, VANADIUM# /DRIDES,	044002
EFFICIENCY-OF-HEAT-RECOVERY,	HEAT-RECOVERY-EFFICIENCY# /EN,	044010
TION, FLOW-STRESS, HARDENING,	HEAT-TREATMENT# /TALS, HYDRIDA	060002
LAR, FUEL-ROCKET, EXPLOSIVES,	HIGH-PRESSURE-TRANSFORMATIONS#	043013
, THERMODYNAMIC-MODEL, STEAM,	HIGH-SULFUR, AMMONIA# /ZED-BED	023009
SPLITTING, NUCLEAR-REACTORS,	HIGH-TEMPERATURES# WATER,	022022
NS, ALKANES# RADIOLYSIS,	HOT-HYDROGEN-ATOMS, HYDROCARBO	030012
CLEAR-ENERGY, STEEL-INDUSTRY,	HTGR-REACTORS, COSTS, REDUCING	033015
THERMOCHEMICAL, PRODUCTION,	HYBRID-PROCESSES, HYBRID#	022028
PRODUCTION, HYBRID-PROCESSES,	HYBRID# THERMOCHEMICAL,	022028
ENING, HEA/ NIOBIUM-CRYSTALS,	HYDRIDATION, FLOW-STRESS, HARD	060002
SAFETY,	HYDRIDE-FETI#	050002
OTIVE-FUELS, PHYSICAL-PROPER/	HYDRIDE-STORAGE-SYSTEMS, AUTOM	044009
EL-CYCLES, VANADIUM, DIFFUSI/	HYDRIDES, HYDROGEN-STORAGE, FU	044003
	HYDRIDES, LANIS, ANALYSIS#	044006
, ELASTIC-PROPERTIES#	HYDRIDES, LUTETIUM, CRYOGENICS	044011
YCLE, METAL-HYDRIDES, MAGNES/	HYDRIDES, MAGNESIUM, STORAGE-C	044010

ON, FUEL-GAS, SULFUR, METALS,	HYDROGEN# COKE-GASIFICATI	023006
ERATION, PRODUCTION-DATA#	HYDROGENATION, FUELS, PLANT-OP	033014
, BROMIDE# THERMOCHEMICAL,	HYDROLYSIS, IRON-BROMIDE, IRON	022026
E, COATINGS, HYDROGEN-DAMAGE,	H2S-ENVIRONMENTS, IRON-SULFIDE	060001
LOW-METERS, LIQUEFACTION#	INSTRUMENTATION, CRYOGENICS, F	042003
FIED, FUEL-STORA/ CRYOGENICS,	INSULATIONS, NATURAL-GAS-LIQUI	042001
UEL-ENRICHMENT, LEAD-ACID-BA/	INTERNAL-COMBUSTION-ENGINES, F	030016
, HYDROGEN-IODIDE, EVOLUTION,	IODINE, CATALYSIS, PRODUCTION#	022025
GE, ARGON, METASTABLE-STATES,	ION-MOLECULE-COLLISIONS# /CHAN	024010
S# PLASMA,	ION-SOURCE, PRODUCTION, PLASMA	034021
UTTERING, CESIUM, MOLYBDENUM,	ION-YIELD, REFRACTORY-METALS,	020015
THERMOCHEMICAL, HYDROLYSIS,	IRON-BROMIDE, IRON, BROMIDE#	022026
XYGEN, HYDROGEN, MANUFACTURE,	IRON-CHLORIDE, SULFUR-DIOXIDE#	022023
ION, IRON, C/ THERMOCHEMICAL,	IRON-CHLORINE, CYCLES, PRODUCT	022029
GEN-DAMAGE, H2S-ENVIRONMENTS,	IRON-SULFIDE-COATINGS, CARBON-	060001
EN-DAMAGE, H2S-ENVIRONMENTS,/	IRON-SULFIDE, COATINGS, HYDROG	060001
PHOTOCHEMICAL-PRODUCTION,	IRON-TITANATE, PRODUCTION#	024001
AL, HYDROLYSIS, IRON-BROMIDE,	IRON, BROMIDE# THERMOCHEMIC	022026
, CHEMICAL-REACTIONS,/ STEAM,	IRON, CHARS, COAL-GASIFICATION	023007
CHLORINE, CYCLES, PRODUCTION,	IRON, CHLORINE-CYCLES# / IRON-	022029
-CYCLES, VANADIUM, DIFFUSION,	ISOTOPE, METAL-HYDRIDES# /FUEL	044003
PHOTOCHEMISTRY, BENZOPHENONE,	KETONES, ALCOHOLS, AMINES, CHA	024003
EGATIVE-ION, HYDROGEN-PLASMA,	LANGMUIR-PROBES, HYDRIDES, NEG	024007
HYDRIDES,	LANIS, ANALYSIS#	044006
O-CHEMISTRY, PHOTO/ CHLORINE,	LASER-ISOTOPE-SEPARATION, PHOT	024015
UM-LASERS, HYDROGEN-PELLETS#	LASER, FUSION, YIELDS, NEODYMI	034019
PLASMA, LANGMUIR-PROBES, HYD/	LASER, NEGATIVE-ION, HYDROGEN-	024007
	LASERS-GAS, HYDROGEN-FUELED#	034016
ION-ENGINES, FUEL-ENRICHMENT,	LEAD-ACID-BATTERIES, OXYGEN# /	030016
EL-GAS, CATALYSIS, FUE/ COAL,	LIQUEFACTION, GASIFICATION, FU	023010
COST, AVAILABILITY, FUELS,	LIQUEFACTION#	010060
ION, CRYOGENICS, FLOW-METERS,	LIQUEFACTION# INSTRUMENTAT	042003
YDROGEN#	LIQUEFACTIONS, EFFICIENCIES, H	042004
ELS, STORAGE-VESSELS, SYNTHE/	LIQUID-HYDROGEN, AUTOMOTIVE-FU	031013
IDS, TRANSPO/ AIRCRAFT-FUELS,	LIQUID-HYDROGEN, CRYOGENIC-FLU	031008
C-FLUIDS, TRANSPORT-AIRCRAFT,	LIQUID-HYDROGEN# /EN, CRYOGENI	031008
PROPERTIES# HYDRIDES,	LUTETIUM, CRYOGENICS, ELASTIC-	044011
TORAGE-CYCLE, METAL-HYDRIDES,	MAGNESIUM-AND-HYDROGEN, EFFICI	044010
L-HYDRIDES, MAGNES/ HYDRIDES,	MAGNESIUM, STORAGE-CYCLE, META	044010
ES, FUELS, ORGANIC-COMPOUNDS,	MANUALS, ORGANIC, COMPOUNDS# /	023012
R-REACTORS, OXYGEN, HYDROGEN,	MANUFACTURE, IRON-CHLORIDE, SU	022023
ONIA-SYNTHESIS, ELECTROLYTIC,	MANUFACTURE# AMM	021021
ELECTROLYSIS, FUELS, WATER,	MANUFACTURE#	021026
OURCES, FUEL-ECONOMY#	MARKET-PENETRATION, ENERGY-RES	010057
WER-PLANT/ HYDRIDING-PARTIAL,	MECHANICAL-FAILURE, NUCLEAR-PO	060005
RADIATION, WATER, PHOTOLYSIS,	MEMBRANES# SOLAR-	024002
DUCTION, ENERGY-STORAGE, GAS,	METAL-HYDRIDE, GAS-TURBINE# /O	021022
ES, MAGNESIUM, STORAGE-CYCLE,	METAL-HYDRIDES, MAGNESIUM-AND-	044010
TROLYTIC-HYDROGEN-PRODUCTION,	METAL-HYDRIDES, STORAGE, CATAL	021024
VANADIUM, DIFFUSION, ISOTOPE,	METAL-HYDRIDES# /FUEL-CYCLES,	044003
E-FUELS, PHYSICAL-PROPERTIES,	METALLIC-COMPOUNDS# /AUTOMOTIV	044009
ET, EXPLOSIVES, HI/ HYDROGEN,	METALLIC, MOLECULAR, FUEL-ROCK	043013
COAL-GASIFICATION, GASES#	METALS-AND-ALLOYS, PIPELINES,	010052

IR/ WATER, NUCLEAR-REACTORS,	OXYGEN, HYDROGEN, MANUFACTURE,	022023
SURFACES/ HYDROGEN, FLOURINE,	OXYGEN, MIXTURES, EXPLOSIONS,	024013
SSIAN-POLARIZATION, HYDRIDES,	OXYGEN, SULFUR, ELECTRONIC-STR	044008
ICHMENT, LEAD-ACID-BATTERIES,	OXYGEN# /ION-ENGINES, FUEL-ENR	030016
SOCIATION, SOLID-MIXTURES#	PALLADIUM, HYDROGEN-ATOMS, DIS	040014
ROGEN-GAS, BREECH-MECHANISMS,	PATENT, PRESSURIZED-HYDROGEN,	034020
M-CARBONATE, SODIUM-FLOURIDE,	PATENT# /ASIFICATION, POTASSIU	023011
FAILURE, NUCLEAR-POWER-PLANT,	PELLET-CLADDING-INTERACTION, F	060005
NSPO/ PIPELINES, NATURAL-GAS,	PETROLEUM, COAL, HYDROGEN, TRA	040016
CTI/ HYDRIDES, VANADIUM, NMR,	PHASE-TRANSITION, DIFFUSION, A	044004
FUEL-CELLS, CA/ HYDROGEN-AIR,	PHOSPHORIC-ACID, ELECTROLYTE,	032018
FUEL-CELL, ELECTROCATALYSIS,	PHOSPHORIC-ACID# FUEL,	032015
NE, LASER-ISOTOPE-SEPARATION,	PHOTO-CHEMISTRY, PHOTOLYSIS, U	024015
ALYTIC-DEHYDROGENATION, PROP/	PHOTO-ENHANCED-PRODUCTION, CAT	024011
-TITANATE, PRODUCTION#	PHOTOCHEMICAL-PRODUCTION, IRON	024001
GRESS-REPT., CHARGE-TRANSFER,	PHOTOCHEMICAL# /-EXCHANGE, PRO	024003
KETONES, ALCOHOLS, AMINES, C/	PHOTOCHEMISTRY, BENZOPHENONE,	024003
UM-COMPLEX#	PHOTOLYSIS, BINUCLEAR-MOLYBDEN	024012
SOLAR-RADIATION, WATER,	PHOTOLYSIS, MEMBRANES#	024002
-SEPARATION, PHOTO-CHEMISTRY,	PHOTOLYSIS, URANIUM, PLUTONIUM	024015
GE-SYSTEMS, AUTOMOTIVE-FUELS,	PHYSICAL-PROPERTIES, METALLIC-	044009
LS, ORGANIC/ COAL-CONVERSION,	PHYSIOCHEMICAL-PROPERTIES, FUE	023012
GASES# METALS-AND-ALLOYS,	PIPELINES, COAL-GASIFICATION,	010052
BINES, RECIPROCATING-ENGINES,	PIPELINES, COMPRESSORS, TRANSP	010058
ICATIONS-FUTURE, FEASIBILITY,	PIPELINES, ECONOMICS# /S, APPL	010053
EUM, COAL, HYDROGEN, TRANSPO/	PIPELINES, NATURAL-GAS, PETROL	040016
ED, ENERGY-TRANSP/ ECONOMICS,	PIPELINES, NATURAL-GAS-LIQUIFI	040015
TA# HYDROGENATION, FUELS,	PLANT-OPERATION, PRODUCTION-DA	033014
SILANE, SILICON, SYNTHESIS,	PLASMA-JET, SOLAR-CELLS, HYDRO	034015
, PLASMAS#	PLASMA, ION-SOURCE, PRODUCTION	034021
ASMA, ION-SOURCE, PRODUCTION,	PLASMAS# PL	034021
EMISTRY, PHOTOLYSIS, URANIUM,	PLUTONIUM# /PARATION, PHOTO-CH	024015
EERING# MILITARY-FUELS,	PORTABLE-FUELS, MILITARY-ENGIN	031010
CATALYSIS, COAL-GASIFICATION,	POTASSIUM-CARBONATE, SODIUM-FL	023011
LITY, FUEL-CELLS, FUE/ FUELS,	POWER-GENERATION, ELECTRIC-UTI	032020
TORS, DESIGN#	POWER-GENERATION, NUCLEAR-REAC	033017
S, BATTERIES, SPACE-VEHICLES,	POWER-SUPPLY# /DROGEN-BATTERIE	032017
S, BREECH-MECHANISMS, PATENT,	PRESSURIZED-HYDROGEN, GUN-LAUN	034020
CH-MECHANISMS, PATENT, PRESS/	PRESSURIZED-HYDROGEN-GAS, BREE	034020
TION, FUELS, PLANT-OPERATION,	PRODUCTION-DATA# HYDROGENA	033014
SAFETY, STORAGE, UTILIZATION,	PRODUCTION, DISTRIBUTION#	050004
ION-BY-PIPELINES, COMPRESSOR,	PRODUCTION, FUEL-PROPERTIES, R	010058
HYBRID# THERMOCHEMICAL,	PRODUCTION, HYBRID-PROCESSES,	022029
FUELS, STEAM-IRON-PROCESS,	PRODUCTION, HYDROGEN#	024004
MICAL, IRON-CHLORINE, CYCLES,	PRODUCTION, IRON, CHLORINE-CYC	022029
PLASMA, ION-SOURCE,	PRODUCTION, PLASMAS#	034021
ION, UTILIZATION#	PRODUCTION, STORAGE, TRANSMISS	010045
CTRIC-UTILITIES, MOBILE-FUEL,	PRODUCTION, STORAGE, SOLAR, EL	030014
HYDRIDES,	PRODUCTION, STORAGE#	010047
CYCLES, WATER, DECOMPOSITION,	PRODUCTION, THERMOCHEMICAL-CYC	022030
Y, METHANOL, HYDROGEN-ECONOMY,	PRODUCTION, TRANSMISSION, STOR	010055
YNTHETIC-FUELS, FOSSIL-FUELS,	PRODUCTION, TRANSMISSION, STOR	010062
GASIFICATION, THERMOCHEMICAL/	PRODUCTION, UTILIZATION, COAL-	010051

TION, THERMOCHEMISTRY, WATER,	PRODUCTION# DECOMPOSI	022024
ELECTROLYSIS, FUELS, WATER,	PRODUCTION#	021025
AL-PRODUCTION, IRON-TITANATE,	PRODUCTION# PHOTOCHEMIC	024001
EVOLUTION, IODINE, CATALYSIS,	PRODUCTION# /HYDROGEN-IODIDE,	022025
TROLYSIS, STORAGE, TRANSPORT,	PRODUCTION# /USTRY, WATER-ELEC	010048
OLS, AMINES, CHARGE-EXCHANGE,	PROGRESS-REPT., CHARGE-TRANSFE	024003
N, CATALYTIC-DEHYDROGENATION,	PROPANOL, RHODIUM, TIN, CHLORI	024011
MAL-WASTE, ELECTROLYTIC-CELL,	PROTEINS, AEROBIC-BACTERIA, AN	020013
BUSTION, ANAEROBIC-DIGESTION,	PYROLYSIS, AGRICULTURAL-RESIDU	020012
AL-REDUCTION, REACTION-YIELD,	PYROLYSIS# /DROGEN-PLASMAS, CO	034017
, HYDROCARBONS, ALKANES#	RADIOLYSIS, HOT-HYDROGEN-ATOMS	030012
XIDE-MANUFACTURE#	RADIOLYSIS, OXYGEN, CARBON-DIO	020014
FUEL-CELL, ELECTRODES,	RATE-LIMITING-STEPS#	032019
IRCONIUM, EMBRITTLEMENT, ACT/	REACTION-KINETICS, HYDRIDES, Z	044012
OGEN-PLASMAS, COAL-REDUCTION,	REACTION-YIELD, PYROLYSIS# /DR	034017
NE-PERFORMANCE, GAS-TURBINES,	RECIPROCATING-ENGINES, PIPELIN	010058
PRODUCTION, FUEL-PROPERTIES,	RECIPROCATING-ENGINE-PERFORMAN	010058
DUSTRY, HTGR-REACTORS, COSTS,	REDUCING-GAS# /NERGY, STEEL-IN	033015
ESIUM, MOLYBDENUM, ION-YIELD,	REFRACTORY-METALS, WORK-FUNCTI	020015
E, ELECTR/ ELECTROCHEMICALLY,	REGENERATIVE, HYDROGEN-CHLORIN	033016
ITION-WATER, THERMOCHEMISTRY,	RESOURCE-MANAGEMENT# /DECOMPOS	022020
IC-DEHYDROGENATION, PROPANOL,	RHODIUM, TIN, CHLORIDE, COMPLE	024011
-GROWTH, HYDROGEN-PRODUCTION,	RHODOPSUEDOMAS, ANAEROBIC, DAR	024014
GAS-EXPLOSIONS, DETONABLE-GA/	SAFETY, ELECTROSTATIC-CHARGE,	050001
	SAFETY, HYDRIDE-FETI#	050002
AEROSPACE, FUELS#	SAFETY, NATURAL-GAS-LIQUEFIED,	050003
PRODUCTION, DISTRIBUTION#	SAFETY, STORAGE, UTILIZATION,	050004
M, COAL, HYDROGEN, TRANSPORT,	SAFETY# /NATURAL-GAS, PETROLEU	040016
ASMA-JET, SOLAR-CELLS, HYDRO/	SILANE, SILICON, SYNTHESIS, PL	034015
, SOLAR-CELLS, HYDRO/ SILANE,	SILICON, SYNTHESIS, PLASMA-JET	034015
OILING, CRYOGENICS#	SLUSH-PREPARATION, GASES-LOW-B	043014
ICATION, POTASSIUM-CARBONATE,	SODIUM-FLOURIDE, PATENT# /ASIF	023011
LICON, SYNTHESIS, PLASMA-JET,	SOLAR-CELLS, HYDROGEN-ATOMS# /	034015
S, AGRICULTURE, ELECTROLYSIS,	SOLAR-COLLECTORS, ELECTRIC-UTI	030014
EL, CONCENTRATING-COLLECTORS,	SOLAR-ENERGY, ALUMINA-NICKEL-C	024005
ELS#	SOLAR-ENERGY, OCEANOGRAPHY, FU	024006
ANAGEMENT, ENERGY-CONVERSION,	SOLAR-HEATING-COOLING, WASTE-U	010051
YSIS, MEMBRANES#	SOLAR-RADIATION, WATER, PHOTOL	024002
CATALYST-ALUMINA-NICKEL, CON/	SOLAR, AMMONIA, DISSOCIATION,	024005
LE-FUEL, PRODUCTION, STORAGE,	SOLAR, ELECTRIC, UTILITIES# /I	030014
HYDROGEN-ATOMS, DISSOCIATION,	SOLID-MIXTURES# PALLADIUM,	040014
UM-MANGANESE, THERMODYNAMICS,	SOLID-SOLUTIONS# /NIUM-ZIRCONI	044007
GEN, NITROGEN, CLAUS-PROCESS,	SOUR, COAL, COAL-GASIFICATION,	023009
YDROGEN-BATTERIES, BATTERIES,	SPACE-VEHICLES, POWER-SUPPLY#	032017
CYCLE, THERMOCHEMICAL, WATER,	SPLITTING, NUCLEAR-REACTORS# /	022027
HERMOCHEMISTRY# WATER,	SPLITTING, NUCLEAR-REACTORS, T	022021
IGH-TEMPERATURES# WATER,	SPLITTING, NUCLEAR-REACTORS, H	022022
, ION-YIELD, REFRACTORY-META/	SPUTTERING, CESIUM, MOLYBDENUM	020015
S, HYDROGEN, OXYGEN, ENGINES/	STEAM-GENERATOR, THERMODYNAMIC	031014
, HYDROGEN# FUELS,	STEAM-IRON-PROCESS, PRODUCTION	024004
FICATION, CHEMICAL-REACTIONS,	STEAM-IRON-REACTORS# /OAL-GASI	023007
S, HYDROGEN, OXYGEN, ENGINES,	STEAM-TURBINES, ELECTRIC-POWER	031014
ZED-BED, THERMODYNAMIC-MODEL,	STEAM, HIGH-SULFUR, AMMONIA# /	023006

ICATION, CHEMICAL-REACTIONS,/	STEAM, IRON, CHARS, COAL-GASIF	023007
COSTS, REDU/ NUCLEAR-ENERGY,	STEEL-INDUSTRY, HTGR-REACTORS,	033015
ENERGY-ROUTES,	STEEL-MAKING, FUELS#	010042
, THERMOMECHANICAL-TREATMENT,	STEEL-18NI, STEELS-MARAGING, E	060006
ANICAL-TREATMENT, STEEL-18NI,	STEELS-MARAGING, EMBRITTLEMENT	060006
MAGNES/ HYDRIDES, MAGNESIUM,	STORAGE-CYCLE, METAL-HYDRIDES,	044010
D-HYDROGEN, AUTOMOTIVE-FUELS,	STORAGE-VESSELS, SYNTHETIC-FUE	031013
N-PRODUCTION, METAL-HYDRIDES,	STORAGE, CATALYSTS, COST# /DGE	021024
LS, PRODUCTION, TRANSMISSION,	STORAGE, CONFERENCES# /SIL-FUE	010062
GEN-ATOMIC, FUEL, EXPLOSIVES,	STORAGE, CRYOGENICS# HYDRO	040017
IES, MOBILE-FUEL, PRODUCTION,	STORAGE, SOLAR, ELECTRIC, UTIL	030014
TION# PRODUCTION,	STORAGE, TRANSMISSION, UTILIZA	010045
INDUSTRY, WATER-ELECTROLYSIS,	STORAGE, TRANSPORT, PRODUCTION	010048
REACTIONS, HYDROGEN, SULFIDE,	STORAGE, TRANSPORTATION# /CAL-	010054
OMY,PRODUCTION, TRANSMISSION,	STORAGE, UTILIZATION, CONFEREN	010055
ON, DISTRIBUTION# SAFETY,	STORAGE, UTILIZATION, PRODUCTI	050004
HYDRIDES, PRODUCTION,	STORAGE#	010047
HARDENING, VANADIU/ HYDRIDES,	STRESS-INDUCED-REORIENTATION,	044002
IS, ELECTROCHEMICAL-ACTIVITY,	STRUCTURAL-CHARACTERISTICS# /S	032021
CHEMICAL-REACTIONS, HYDROGEN,	SULFIDE, STORAGE, TRANSPORTATI	010054
, HYDROG/ AMMONIA-CONVERSION,	SULFIDED-CATALYST, WASTE-WATER	023009
ICATION, CONVERSION, AMMONIA,	SULFIDED, CATALYST, HYDROGEN-A	023009
,-MANUFACTURE, IRON-CHLORIDE,	SULFUR-DIOXIDE# /GEN, HYDROGEN	022023
LARIZATION, HYDRIDES, OXYGEN,	SULFUR, ELECTRONIC-STRUCTURE#	044008
-BE/ AMMONIA-SYNTHESIS, COAL,	SULFUR, FERTILIZERS, FLUIDIZED	023008
COKE-GASIFICATION, FUEL-GAS,	SULFUR, METALS, HYDROGEN#	023006
, WATER, DECOMPOSITION, PROD/	SULFUR, THERMOCHEMICAL, CYCLES	022030
LUSH-GEL, AEROSPACE-VEHICLES,	SUPERCOOLING, THERMODYNAMIC-PR	043012
FUELS/ CATALYSTS, OXIDATION,	SURFACE-ELECTRONIC-PROPERTIES,	031012
OXYGEN, MIXTURES, EXPLOSIONS,	SURFACES, CHEMICAL-REACTION-KI	024013
N-GENERATION, FUEL-CHEMISTRY,	SYNFUEL, FUEL-OIL-ADDITIVES, F	010041
-REACTORS, BREEDING-BLANKETS,	SYNFUEL, HYDROGEN-PRODUCTION#	024009
N, THERMOCHEMICAL-PRODUCTION,	SYNFUEL# /ON, COAL-GASIFICATIO	010051
HANE-SEPARATION, HYDROCARBON/	SYNTHESIS-OF-HYDROCARBONS, MET	034018
ELLS, HYDRO/ SILANE, SILICON,	SYNTHESIS, PLASMA-JET, SOLAR-C	034015
OTIVE-FUELS, STORAGE-VESSELS,	SYNTHETIC-FUELS, AUTOMOTIVE, C	031013
PRODUCTION, TRANSMISSION, S/	SYNTHETIC-FUELS, FOSSIL-FUELS,	010062
-EVOLUTION, ALTITUDE-EFFECTS,	TEMPERATURE-EFFECTS# /HYDROGEN	020011
MICS, METHANOL, ELECTROLYTES,	THERMAL-CATALYTIC-DISSOCIATION	032012
R, DECOMPOSITION, PRODUCTION,	THERMOCHEMICAL-CYCLES, WATER-D	022030
EEDSTOCKS, FUELS-FROM-WASTES,	THERMOCHEMICAL-GENERATION, HYD	010041
ILIZATION, COAL-GASIFICATION,	THERMOCHEMICAL-PRODUCTION, SYN	010051
METALS, ELECTRONIC-STRUCTURE,	THERMOCHEMICAL-PROPERTIES# /N-	044005
DECOMPOSITION, PROD/ SULFUR,	THERMOCHEMICAL, CYCLES, WATER,	022030
AMMONIUM-IODIDE, HYDROGEN-I/	THERMOCHEMICAL, DECOMPOSITION,	022025
ON-BROMIDE, IRON, BROMIDE#	THERMOCHEMICAL, HYDROLYSIS, IR	022026
CYCLES, PRODUCTION, IRON, C/	THERMOCHEMICAL, IRON-CHLORINE,	022029
BRID-PROCESSES, HYBRID#	THERMOCHEMICAL, PRODUCTION, HY	022028
NG, NUCLEAR-RE/ CLOSED-CYCLE,	THERMOCHEMICAL, WATER, SPLITTI	022027
ITION-W/ DECOMPOSITION-WATER,	THERMOCHEMISTRY, 630 DECOMPOS	022020
RY, 630 DECOMPOSITION-WATER,	THERMOCHEMISTRY, RESOURCE-MANA	022020
TION# DECOMPOSITION,	THERMOCHEMISTRY, WATER, PRODUC	022024
SPLITTING, NUCLEAR-REACTORS,	THERMOCHEMISTRY# WATER,	022021

, FERTILIZERS, FLUIDIZED-BED, THERMODYNAMIC-MODEL, STEAM, HI 023008
SPACE-VEHICLES, SUPERCOOLING, THERMODYNAMIC-PROPERTIES# /ERO 043012
EN, ENGINES/ STEAM-GENERATOR, THERMODYNAMICS, HYDROGEN, OXYG 031014
TROLYTES, THERMAL/ FUEL-CELL, THERMODYNAMICS, METHANOL, ELEC 032012
TITANIUM-ZIRCONIUM-MANGANESE, THERMODYNAMICS, SOLID-SOLUTION 044007
EEL-18NI, STE/ EMBRITTLEMENT, THERMOMECHANICAL-TREATMENT, ST 060006
M, TITANIUM# CRYOPUMPS, THERMONUCLEAR-REACTORS, TRITIU 042002
NG-BLANKETS, SYNFUEL, HYDROG/ THERMONUCLEAR-REACTORS, BREEDI 024009
OGENATION, PROPANOL, RHODIUM, TIN, CHLORIDE, COMPLEXES# /YDR 024011
THERMODYNAMICS, SO/ HYDRIDES, TITANIUM-ZIRCONIUM-MANGANESE, 044007
RMONUCLEAR-REACTORS, TRITIUM, TITANIUM# CRYOPUMPS, THE 042002
STRUCTURE, THERMOC/ HYDRIDES, TRANSITION-METALS, ELECTRONIC- 044005
NFIGURATIONS, HYDR/ HYDRIDES, TRANSITION-METALS, ELECTRON-CO 044001
PRESSOR, PRODUCTION, FUEL-PR/ TRANSMISSION-BY-PIPELINES, COM 010058
HYDROGEN-ECONOMY,PRODUCTION, TRANSMISSION, STORAGE, UTILIZA 010055
LS, FOSSIL-FUELS, PRODUCTION, TRANSMISSION, STORAGE, CONFERE 010062
PRODUCTION, STORAGE, TRANSMISSION, UTILIZATION# 010045
D-HYDROGEN, CRYOGENIC-FLUIDS, TRANSPORT-AIRCRAFT, LIQUID-HYD 031008
WATER-ELECTROLYSIS, STORAGE, TRANSPORT, PRODUCTION# /USTRY, 010048
S, PETROLEUM, COAL, HYDROGEN, TRANSPORT, SAFETY# /NATURAL-GA 040016
ECTROLYSIS, HYDROGEN-STORAGE, TRANSPORTATION, ELECTROLYTIC-H 021024
, HYDROGEN, SULFIDE, STORAGE, TRANSPORTATION# /CAL-REACTIONS 010054
INES, PIPELINES, COMPRESSORS, TRANSPORTATION# /PROCATING-ENG 010058
UMPS, THERMONUCLEAR-REACTORS, TRITIUM, TITANIUM# CRYOP 042002
ST/ FUEL-ENRICHMENT, ENGINES, TURBINES, TURBOCHARGERS, COMBU 031007
NRICHMENT, ENGINES, TURBINES, TURBOCHARGERS, COMBUSTION, ETH 031007
PHOTO-CHEMISTRY, PHOTOLYSIS, URANIUM, PLUTONIUM# /PARATION, 024015
ON, STORAGE, SOLAR, ELECTRIC, UTILITIES# /ILE-FUEL, PRODUCTI 030014
, THERMOCHEMICAL/ PRODUCTION, UTILIZATION, COAL-GASIFICATION 010051
CTION, TRANSMISSION, STORAGE, UTILIZATION, CONFERENCES# /ODU 010055
IBUTION# SAFETY, STORAGE, UTILIZATION, PRODUCTION, DISTR 050004
CTION, STORAGE, TRANSMISSION, UTILIZATION# PRODU 010045
YDROGEN-STORAGE, FUEL-CYCLES, VANADIUM, DIFFUSION, ISOTOPE, 044003
N, DIFFUSION, ACTI/ HYDRIDES, VANADIUM, NMR, PHASE-TRANSITIO 044004
CED-REORIENTATION, HARDENING, VANADIUM# /DRIDES, STRESS-INDU 044002
UCTION# ANAEROBIC-BACTERIA, WASTE-TREATMENT, HYDROGEN-PROD 024008
RSION, SOLAR-HEATING-COOLING, WASTE-UTILIZATION# /ERGY-CONVE 010061
ONVERSION, SULFIDED-CATALYST, WASTE-WATER, HYDROGEN, NITROGE 023009
CTION, THERMOCHEMICAL-CYCLES, WATER-DECOMPOSITION# /N, PRODU 022030
RANSPORT, PROD/ GAS-INDUSTRY, WATER-ELECTROLYSIS, STORAGE, T 010048
LFUR, THERMOCHEMICAL, CYCLES, WATER, DECOMPOSITION, PRODUCTI 022030
ELECTROLYSIS, FUELS, WATER, MANUFACTURE# 021026
N, HYDROGEN, MANUFACTURE, IR/ WATER, NUCLEAR-REACTORS, OXYGE 022023
SOLAR-RADIATION, WATER, PHOTOLYSIS, MEMBRANES# 024002
COMPOSITION, THERMOCHEMISTRY, WATER, PRODUCTION# DE 022024
ELECTROLYSIS, FUELS, WATER, PRODUCTION# 021025
TORS, HIGH-TEMPERATURES# WATER, SPLITTING, NUCLEAR-REAC 022022
TORS, THERMOCHEMISTRY# WATER, SPLITTING, NUCLEAR-REAC 022021
CLOSED-CYCLE, THERMOCHEMICAL, WATER, SPLITTING, NUCLEAR-REAC 022027
RPTION, NAT/ BRITTLE-FAILURE, WATERWALL-TUBES, HYDROGEN-ABSO 060004
HYDROGEN-ENERGY-STORAGE, WIND-POWER, ELECTRIC-POWER# 030017
ION-YIELD, REFRACTORY-METALS, WORK-FUNCTION# /, MOLYBDENUM, 020015
OGEN-PELLETS# LASER, FUSION, YIELDS, NEODYMIUM-LASERS, HYDR 034019
REACTION-KINETICS, HYDRIDES, ZIRCONIUM, EMBRITTLEMENT, ACTI 044012